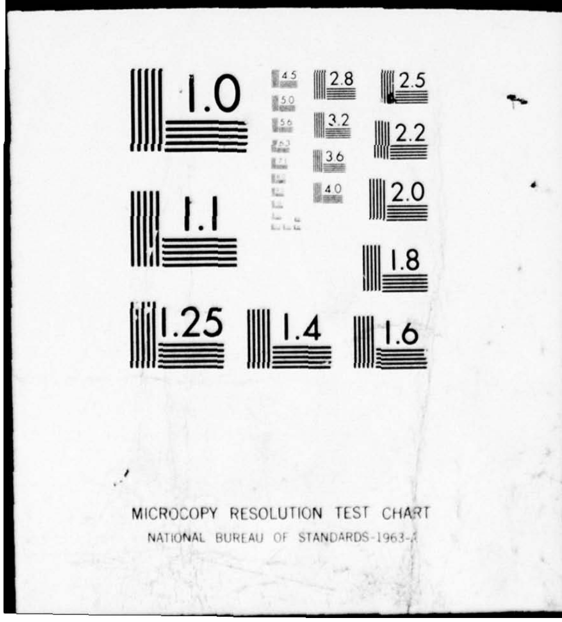
AD-A040 065 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C OFFICE--ETC F/G 5/3
AVIATION FORECASTS FY 1977 - 1988, SUMMARY AND BRIEFING CONFERE--ETC(U)
DEC 76

UNCLASSIFIED FAA-AVP-77-16 NL

1 OF 3
AD
A040065

04006


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FAA-AVP-77-16

(11)

ADA040065

AVIATION FORECASTS FY 1977 - 1988

SUMMARY AND BRIEFING CONFERENCE

December 2, 1976

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION POLICY
Aviation Forecast Branch
Washington, D.C. 20591

Technical Report Documentation Page

1. Report No. (14) FAA-AVP-77-16	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle (6) AVIATION FORECASTS FY 1977 - 1988, Summary and Briefing Conference		5. Report Date (11) December 2, 1976
		6. Performing Organization Code
7. Author(s) Aviation Forecast Branch		8. Performing Organization Report No.
9. Performing Organization Name and Address Department of Transportation Federal Aviation Administration 800 Independence Avenue, S. W. Washington, D. C. 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address		13. Type of Report and Period Covered Conference
		14. Sponsoring Agency Code
15. Supplementary Notes (12) 285 p.		

16. Abstract

The second annual Federal Aviation Administration Forecast Conference was held on December 2, 1976, at Reston, Virginia. This report of the proceedings includes all the formal presentations and some representative questions and answers. This Conference, like the previous one, was held for the primary purpose of (1) reemphasizing the importance of accurate data and aviation activity forecasts for Federal Aviation Administration (FAA) planning and budgetary purposes, and (2) stimulating the interchange of ideas between FAA and the aviation community.

Some of the topics discussed included: growth anticipation in the general aviation and air taxi industries, aircraft financing difficulties of the airlines, long-term aviation developments. Highlights of the aviation Forecasts for Fiscal Years 1977-1988, forecasting techniques and industry analyses of completed research were also discussed. This publication includes Conference papers as well as questions and answers raised during the discussion period.

17. Key Words	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Va. 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	284	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

406648

(2 2d)

FOREWORD

The second annual Federal Aviation Administration Forecast Conference was held on December 2, 1976, at Reston, Virginia. The Conference was attended by approximately 250 people from various segments of the aviation community. This report of the proceedings includes all the formal presentations and some representative questions and answers. This Conference, like the previous one, was held for the primary purpose of (1) reemphasizing the importance of accurate data and aviation activity forecasts for Federal Aviation Administration (FAA) planning and budgetary purposes, and (2) stimulating the interchange of ideas between FAA and the aviation community, particularly between the "forecasters" and the "forecast users." We believe that these purposes were accomplished.

In his remarks, Dr. McLucas, the FAA Administrator, commented on the excellent growth anticipated in the general aviation and air taxi industries and on the apparent aircraft financing difficulties of the airlines. Fred Meister presented possible long-term aviation developments which may arise, given diverse alternative scenarios.

The Aviation Forecast Branch presented highlights of the Aviation Forecasts for Fiscal Years 1977-1988 and described some of the thought processes, forecasting techniques, and assumptions which underlie graphs and data presented in

various FAA forecast publications. In addition, analysts and industry representatives discussed the progress and results of on-going and recently completed research sponsored by the Office of Aviation Policy.

This publication includes Conference Papers as well as representative questions and answers raised during the discussion period. As can be surmised from the questions, participants challenged some of our analytical techniques, assumptions, and conclusions. We consider this exchange of ideas highly valuable and hope to continue the dialogue between FAA and other members of the aviation community in this as well as other areas.

We take this opportunity to thank the participants, particularly those from industry who gave prepared speeches, raised interesting questions, or offered valuable comments about the presentations, the format, and the location of the Conference. We encourage further comments on all aspects of the Conference in order that we may improve the effectiveness of such forums in the future.

DUANE FREER
Associate Administrator for Policy
Development and Review (Acting)

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FAA FORECAST CONFERENCE

FISCAL YEARS 1977-1988

DATE: Thursday, December 2, 1976

PLACE: Sheraton International
Reston, Virginia

TIME: 8:00 AM to 4:00 PM

AGENDA

8:00 AM — Bus Departs FOB-10A
800 Independence Ave., S.W.
Washington, D. C.

8:00-9:30 AM — Registration
(Lobby, Sheraton International)

Morning Session

Topics		Speakers
9:30 AM	Welcome	Dr. John L. McLucas Administrator Federal Aviation Administration
9:45 AM	Opening Remarks	Frederick A. Meister Associate Administrator Policy Development & Review (Acting)

Moderator - Duane Freer

10:00 AM	Highlights of 1977-1988 Aviation Forecasts	Gene S. Mercer Chief, Aviation Forecast Branch
10:15 AM	Air Carrier Activity	Bernard Hannan Transportation Analyst
10:30 AM	Questions and Answers	- - - - -
10:45 AM	Coffee Break	- - - - -

11:00 AM	Air Service to Small Communities	Regina Van Duzee Industry Economist
11:15 AM	Forecasts of General Aviation Activities	Thomas F. Henry Industry Economist
11:30 AM	Military Forecasts	Hugh J. May Industry Economist
11:40 AM	Questions and Answers	- - - - -
12:00 - 1:30	L U N C H	

Speaker: Art Ford
Vice President
Long Range Planning
Delta Airlines

Afternoon: Concurrent Sessions
(Discussion and comments after each presentation)

AIR CARRIER SESSION

Topics		Speakers
1:30 PM	International Aviation Forecasts	Bernard Hannan (Moderator)
		Randall J. Pozdena Transportation Analyst Transportation Center Stanford Research Institute (SRI)
	Forecasting for U.S. International Air Carriers	Carl T. Norris Senior Economist Market Development Douglas Aircraft Co. McDonnell Douglas Corp.

Topics		Speakers
2:15 PM	Air Cargo Forecasts	Bernard Hannan (Moderator)
	Air Cargo: Model Developments and Forecasts	Domenic Maio Transportation Analyst Transportation System Center (TSC)
	Industry Air Cargo Forecasts	Michael D. Krambs Director, Marketing Research and Planning Flying Tiger Line
3:00 PM	Coffee Break	- - - - -
3:15 PM	Air Carrier HUB Forecasts	Regina Van Duzee (Moderator)
		David W. Bluestone Consultant System Analysis Research Corp. (SARC)
	Air Carrier HUB Forecasts	Charlotte Chamberlain Economist Transportation Systems Center (TSC)
	Macro-Micro Forecast Relationships	Cecil Brown Manager, Long Range Forecasting Delta Airlines
4:00 PM	Closing Remarks	- - - - -
4:15 PM	Bus Departs for FOB-10A	- - - - -

GENERAL AVIATION SESSION

1:30 PM	Aircraft Operations at FAA Tower and Nontower Airports	James Hines (Moderator)
	Quick Response Computer Analyses for Tower Operations	Ronald H. Hobbs Vice President and Senior Systems Consultant Advanced Technology, Inc.

	National General Aviation Nontower Airport Operations and Tower plus Nontower Airport Operations Forecast	Bruce L. Brown Senior Project Manager Systems Consultant, Inc.
	The Impact of Fixed-Base Operators' Activities at Nontowered Airports	Lawrence L. Burian President & Chief Executive Officer National Air Transportation Association (NATA)
2:15 PM	New Developments in Terminal Area Forecasting	Jonathan Tom (Speaker/ Moderator)
	New Developments in Terminal Area Forecasting from a Micro point-of-view	John M. Duggan Director, Airport Project Development Howard, Needles, Tammen and Bergendoff
3:00 PM	Coffee Break	- - - - -
3:15 PM	FAA/Bureau of the Census Survey of General Aviation	Stephen Vahovich (Moderator)
	Design and Conduct of General Aviation Survey	Dennis Stoudt Survey Statistician Demographic Surveys Division The Bureau of the Census
	Results of General Aviation Survey	Stephen Vahovich Industry Economist Federal Aviation Administration
	Comments on FAA Census Survey Results	Gil Quinby Senior Vice President Narco Avionics
4:00 PM	Closing Remarks	- - - - -
4:15 PM	Bus departs for FOB-10A	- - - - -

REMARKS PREPARED FOR DELIVERY BY
DR. JOHN L. McLUCAS, ADMINISTRATOR
FEDERAL AVIATION ADMINISTRATION
AT THE FAA AVIATION FORECAST CONFERENCE
RESTON, VIRGINIA
DECEMBER 2, 1976

Forecasting is a particularly hazardous undertaking but one that is becoming increasingly necessary in a world growing daily more complex. Without reliable forecasts, long range planning is impossible. And all of us are involved in an industry where such planning efforts are absolutely essential to success.

We have asked you all here today because we honestly want to increase both the insight and input of the aviation industry into the FAA forecasts. I'm not naive enough to believe that we will ever come up with standardized industry-wide forecasting techniques. There are too many diverse and, often, competing elements of the industry. And perhaps too many vested interests as well. But I do think we can narrow the gaps between the different sets of forecast figures that are turned out by government and the various trade associations.

FAA never has regarded forecasting as a paper exercise. We take the process quite seriously and results are used to support the agency's budget requests and for making vital policy decisions. And I think our forecasting techniques are becoming increasingly more sophisticated. Last year, for the first time, we included alternate long-range scenarios keyed to different sets of economic assumptions. This year's edition continues the practice.

An innovation in the new forecast report is a projection for the growth of air cargo in both domestic and international business. This reflects the increasing importance of air cargo in airline operations.

We've also included, for the first time, a forecast of military aircraft based in the continental U.S. since this impacts on FAA operations. As a former Secretary of the Air Force, I was rather disappointed to see almost no growth projected in the military fleet during this period.

One thing that strikes me in reviewing the latest Aviation Forecasts is the very healthy growth trend reflected for general aviation. It's clear that this segment is destined to play an increasingly important role in meeting our total air transportation needs.

Our forecasts indicate a steady annual growth in the active general aviation fleet of about 4 percent over the next dozen years. It emphasizes, I think, more than any other aviation business indicator, the growing public reliance on air transportation for both business and industry as well, of course, in recreational pursuits. Moreover, the 6.3 percent annual increase in G/A hours flown during the same period reflects a greater utilization of the fleet. Interestingly, I also noted in our projections, that the largest growth in the G/A fleet occurs in the multi-engine and turbine classes. This points to an increasing interest by the aviation community in speed and range and more sophisticated aircraft. It also connotes an increased requirement for more pilots trained in the use of more spohisticated airborne equipment.

Today, our active aircraft fleet comprises approximately 191,000 planes of all types. About 88 percent of the current fleet are general aviation aircraft; 11 percent are military planes stationed in the states; and only one percent of the fleet are scheduled air carriers. By 1988, the fleet will increase to some 290,746 aircraft. The G/A portion of the total fleet will grow to 92 percent of the total in that time frame. The scheduled fleet will remain at about one percent of the total while the military percentage of the total fleet will shrink to about 7 percent.

We are also projecting a very substantial growth in the air taxi segment of our industry which remains bracketed in the general aviation category. I say "which remains bracketed in the general aviation industry," because I am not entirely sure that the air taxi/commuter elements of the business should be lumped in the general aviation category. Nevertheless, we anticipate a substantial growth in this facet of air transportation during the 1977/1988 forecast period. The forecasts are optimistic for a number of reasons. For one thing, in the present climate of pressure for regulatory reform the Civil Aeronautics Board has shown an increasing tendency to allow local service carriers to abandon unprofitable routes in favor of commuters. Since commuters providing replacement service with small aircraft usually offer more frequent flights than the skeds, they create a substantial increase in operations. I think this trend will not only continue for some time to come but will increase markedly during the next ten to 15 years.

As a result, the increases projected for general aviation are bound to impact heavily on FAA operations. Total operations in 1977 are expected to increase by 6.6 percent over FY 1976. But for the complete forecast period, we are pegging the average yearly growth rate for FAA operations at 4.6 percent through FY 1988. I think we'll see the most growth occurring in itinerant operations, primarily due to expanding air taxi operations along with an attendant growth in other general aviation activity, plus some slight increase in air carrier operations.

Like total aircraft operations, instrument operations at FAA towers are expected to increase in the years ahead. However, because further implementation of Terminal Control Areas and Stage III of expanded radar service is not anticipated after FY 1976, this will cause instrument operations to grow at a more normal rate. However, general aviation, we believe, will continue past trends and increase its use of sophisticated avionics equipment. Consequently, the general aviation category of instrument operations should grow at about 7 percent annually through FY 1988.

Aircraft handled at FAA Air Route Traffic Control Centers are expected to increase 28 percent and 64 percent by 1981 and 1988, respectively. Specifically, we believe, air carrier volume will increase 17 percent by 1981 and 44 percent by 1988. But in the same time span, the number of general aviation aircraft handled will rise more spectacularly, 65 percent and 123 percent respectively. The fact is general aviation aircraft handled will account for 34 percent of the total in 1988 compared with 25 percent today.

To sum it up, general aviation is in excellent health. Its growth is steady, economically viable, its horizons seem limitless. On the other hand, there is the air carrier industry. That industry, upon which much of our fortunes domestically and internationally depend, is beset by economic difficulties.

We are forecasting an average growth rate of slightly more than 6 percent per year between now and 1988 in revenue passenger-miles for the domestic scheduled air carriers. Stated another way, the total enplaned passengers at U.S. airports, will increase from 221 million in 1976 to 465 million by 1988. Passenger air traffic will more than double during the next twelve-year period.

Not long ago, the Air Transport Association estimated that the U.S. scheduled carriers will require a major capital investment program of $5 billion during the rest of the 1970's, and $60 billion during the 1980's. However, despite its huge equipment expansion program forecast, the air carrier industry has not really been able to get it underway. The principal factor causing the air carriers to delay their orders for new equipment is their inability to raise the capital required to purchase this equipment.

As a recent study accomplished for the FAA pointed out, "The financial community, including insurance companies and the banking industry, has progressively withdrawn from the aviation marketplace since 1970." What's more, the Report continued, "The financial community will not return to the aviation marketplace until stability and profitability have been restored." The recent history of the airline industry's profit, obviously, has not as yet restored the financial industry's confidence. In 1967 the airline industry enjoyed a record $415 million net income. This dropped steadily until it reached a $201 million loss in 1970. It then increased to a level of $322 million in 1974, but immediately dropped to a $72 million loss in 1975. 1976 is forecast to be a good year, with forecasts for earnings between $200 million to $400 million. So it's easy to see why the financial community gets nervous when air transportation is mentioned.

Meanwhile, we've been doing our homework. The FAA and the Department of Transportation have been investigating the question of the ability of the air carriers to purchase new equipment. As far as the basic mission of the FAA in developing the nation's air traffic system is concerned, this is of considerable importance. We do not as yet know the answer. However, as you know, yesterday, Secretary Coleman held hearings on the need for special financing provisions to enable aircraft operators to meet the Part 36 noise emission standards. He also asked for discussion about the type of provisions, if any, that should be established, and how they can be designed to take into account the importance of limiting any involvement of the Federal Government in capital investment decisions that should be made in the private sector.

The meeting also dealt with the extent of noise reduction benefit achievable from a retrofit program compared to the noise reduction achievable from the replacement of the older four-engine jet aircraft that do not meet Federal noise standards either by currently available aircraft or by more advanced technology aircraft currently being designed. The nature and extent of additional benefits that would be realized through a replacement program, including increased employment opportunities in the aerospace and related industries, energy conservation resulting from improved fuel efficiency, aircraft technological advancement, and the improved opportunities for American aerospace manufacturers in world markets were also discussed.

One proposal that has been put forward by the ATA is that current domestic ticket tax be reduced from 8 percent to 5 percent and then a 2 percent ticket surcharge be added for a retrofit/replacement fund. For international tickets the current international departure tax would be reduced from $3 to $2, and a new $2 noise reduction surcharge would be added and the proceeds would go into the retrofit/replacement fund. Each air carrier would then have an entitlement to amounts equal to those generated by its actual operations.

Each carrier flying four engine aircraft not meeting FAR-36 standards would be entitled to draw amounts from the fund equal to the costs of retrofitting these aircraft. As an incentive for buying new aircraft to replace older noisy aircraft, each carrier would receive a replacement allowance based on the carrier's total contribution. The replacement entitlement would be decreased by the amount that the carrier chooses to use to retrofit a portion of its fleet.

The final decision on the procedure that will be used to finance the retrofit/replacement program is several months away, but it does demonstrate how many parties may benefit from a program that is essentially directed towards improving the environment. The public would benefit from this program by the reduction in the noise level caused by aircraft. The aerospace industry would benefit if the noisier aircraft are replaced rather than retrofitted. The nation's general economy would benefit from the increased employment in the aerospace industry, and, if newer technology aircraft were manufactured sooner by our aerospace industry, it would help to insure our world leadership in the sale of commercial aircraft which would in turn benefit our balance of trade position.

Lastly, it would allow the air carriers to begin the purchase of new aircraft for the growth we see in air travel in the years to come and, possibly, this will cause the financial community to once more look at the airline industry in a more favorable light.

In closing, I would personally like to ask that you send me your comments on this conference and the forecasts that will be discussed. It is very important that we are sure of these forecasts because, if we are to handle efficiently and safely, the 400 million passenger trips that will be taken per year by the mid 1980's, the nearly 150 percent increase in service by commuters and air taxis to small communities and the nearly 80 percent increase in operations by general aviation aircraft, we will need to continue the objective of building a strong aviation system to meet the needs of the American public.

Looking Ahead in Aviation

- Frederick A. Meister
Associate Administrator
Policy Development & Review (Acting), FAA

Good morning, it is a pleasure to be here with you today. This conference is timed to coincide with the unveiling of FAA's latest aviation forecasts. Today you will be hearing our projections of aviation activity through 1988. You will also hear a discussion of the assumptions and methodology underlying the forecasts. Finally you will have a chance to comment on any aspect of the forecasts, and I hope you will take advantage of the opportunity. No matter how good this document is, there will always be room for improvement.

I won't dwell on the details of the forecasts or their underlying assumptions and methodology. Gene Mercer and his staff are well prepared to do that. Instead, I want to spend a few minutes discussing why we need a longer time horizon in aviation planning and what we in FAA are doing about it.

You will note in the appendices of the forecast book that standard econometric techniques were used to develop the forecasts. These models require certain exogenous inputs like gross national product and per capita disposable income, and we derive these inputs from the models of Wharton Econometric Forecasting Associates, Inc. The econometric modeling techniques our staff and Wharton use are well developed, and modern data processing systems permit fairly easy manipulation of the models, so that we can test the implications of alternative hypotheses.

Remember one important unstated assumption in the Wharton model, our own forecasting models, and others--the future will be mostly a continuation of the recent past. Even though the events of recent years might make you think otherwise, this still is a good assumption for the near future--say the next five to seven years. Think of how long changes from current trends and practices take in our society. If the changes involve a new federal role, new legislation must be enacted. Absent a national emergency, new federal legislation takes a long time. As an example, I understand the Congressional Clearinghouse for the Future recently found that on the average about seven years--or three and a half Congresses--elapse from first introduction of an idea in Congress until actual passage of legislation. Also, consider any changes that require major new construction.

We all have our favorite examples of construction projects which have fallen far behind schedules. One of mine is the Washington Metro System; seven years passed from groundbreaking in 1968 until the first trains ran on less than five miles of track last year. A system had been discussed since before World War I. Also I'll even propose Meister's law, for you to ponder. It is, "Lead Times Never Get Shorter." We all suffer from the length of coordination and analysis required for major decisions. It will tend to get worse as the cost of wrong decisions increases rapidly. More and more interest groups learn how to "Use the System," and society becomes ever more interdependent. The long and lengthening lead times required for major events call for extended forecasting. Using econometric methods, we can look--and see better--up to ten years in the future. Of course, the farther out in the future we try to project, the greater is the probability of structural change. And the lesser chance that regression coefficients will be accurate predictors. Beyond ten years, the number of possibilities really opens up; and, if we want to attempt longer range forecasts, say to 25, or even 50 years, we have to use quite different methods. Better techniques for doing this are emerging, both in industry and Government. We in FAA are beginning to use them.

We in aviation need to become familiar with such new approaches. For example, in FAA we might need the fourth generation air traffic control system in the 1990's. To have it in place in the 90's, we should be addressing R and D requirements now. That means that today we need answers to a number of questions. For example, will the growth that will warrant installation of the fourth generation actually take place? If development starts too soon, will the final system use inferior technology? Will aviation activity growth return to the pattern of the 60's? We can and will continue to squeeze more capacity out of existing airports, but we know that if aviation growth continues as in the past, some major new airports will be needed before the turn of the century. What cities can make do with improvements to existing airports? Where should we begin assembling the parcels of land that will be needed for new airport construction 10 to 15 years from now? And what about the "Energy Crises" or the basic materials crisis of the future? We cannot be caught napping as we were in '73.

As I said a few minutes ago, we are starting to use some of the new longer range forecasting tools in FAA. I have set up a group in the Office of Aviation Policy to work alongside Gene's staff and do just this. Its objective is not to predict the future. It recognizes that many "Alternative Futures" could evolve and that it must deal simultaneously with the plausible range of these alternative future worlds, or scenarios. In contrast, Wharton, Gene's shop, and other traditional forecasting groups usually treat only one most likely future and foreseeable variants thereof. Our System Concepts Branch is using five scenarios. The scenarios include a much greater proportion of qualitative judgment than our aviation forecasts. They are written as general socioeconomic and aviation histories from the point of view of a person writing in the year 2000 about the past quarter century. These histories include many different kinds of demographic, economic, sociological and technical developments on the socioeconomic side as well as wide ranging discussions of developments in aviation and other modes. Traditional forecasts, of course, cover a much more limited future. Also the quantitative trends underlying the scenario narratives are not merely extrapolations. They were made with a new technique called trend impact analysis which uses a computer program to modify trend extrapolations to account for the expected impacts of unprecedented future events.

I would like to take this opportunity to discuss the development and scope of two of the scenarios in more detail--a very optimistic future we call "Individual Affluence" and a pessimistic secenario we call "Muddling Through." As we develop socioeconomic scenarios, we have to make some starting assumptions. Otherwise we have no "secure tie-down." We call this setting the scenario space, and we do it by projecting varying plausible combinations of high and low GNP and population growth. Our individual affluence scenario projects low population growth, continuing the pattern of recent years, so that the U.S. population grows to 250 million in the year 2000 compared to about 215 million today. GNP growth, on the other hand, sharply deviates from reccent trends and reaches 5 percent a year in the 90's, so that year 2000 GNP is $4.1 trillion, in 1973 dollars, compared to $1.3 trillion in 1975. Four other parameters, adult population, GNP per capita, disposable personal income, and personal consumption expenditures were derived from total population and GNP, and thirteen other parameters were projected with trend impact analysis. All these projections resulted in a socioeconomic scenario narrative.

Here is a capsule summary of that narrative:

> Low population growth during a period of high economic growth gave each citizen a larger share. The strong Federal Government had explicit goals. Population growth was low and in line with newly developed energy and material supplies. The Government policies were anticipatory, not reactive. There was in this world a great deal of environmental consciousness and regulation; policies were constantly tested to determine whether or not they met the broadest public need.

The narrative and quantitative projections then formed a context for describing qualitatively and quantitatively a possible evolution of the national aviation system during the final quarter of the century. Here are some highlights of the national aviation system in the year 2000 assumed to develop in that scenario:

--489 billion domestic RPM's

--788 million enplanements

--182 million total aircraft operations

--5,660 air carrier aircraft including new extra large transports and 150 passenger jet STOLs

--Installation of the 4th generation air traffic control system beginning in 1990

--Several new large regional and feeder airports

The <u>muddling through</u> scenario was developed in the same way. Its portion of the scenario space is determined by high population growth and low economic growth, so that by the year 2000, population soars to 297 million, but GNP reaches only $2.1 trillion 1973 dollars. Here is a capsule description of what results from that combination of factors:

> Despite low growth in gross national product, population grew at a high rate and things went downhill from the 1970's. The United States never seemed to be able to "get it all together." When it tried to curb inflation, recession followed; when recession was the target,

inflation accelerated. Muddling through was the norm. Cohesive policies which lasted beyond the Presidential term were very unusual. The result, inevitably, was frustration. Who was at fault? Industry said Government; Government said Industry; the public faulted both; and Government and Industry claimed the public did not understand. Large corporations were nationalized. Regional authorities were established. For several reasons, the last quarter century was not a repetition of the depression years of the 1930's. In the latter part of the century, the nation was more urbanized, Federal programs had reduced unemployment rates, and large-scale quasi-public corporations functioned with adequate but reduced efficiency. But the feeling of depression was inescapable. This was the modern depression--and it was long lasting.

Now, some year-2000 aviation highlights associated with that unhappy state of affairs:

--168 billion domestic RPM's

--272 million enplanements

--52 million total aircraft operations

--2,430 air carrier aircraft

--Only elements of the upgraded third

--Nationalized air carriers and airports.

Now I will show a viewgraph that is a summary quantitative comparison of the scenarios (see Figure 1).

What does all this mean for the FAA? In very broad terms, here is a picture of how the problems change across the range of conditions (see Figures 2 and 3).

In conditions of no growth or very limited growth, presently planned improvements in capacity, efficiency and safety would meet continuing system needs. However, we would be faced with serious management problems since all of our criteria and decision rules have been structured by our growth experience. For example, faced with no-growth prospects we would have to seriously examine the role of research and development in the NAS.

As we proceed to higher growth conditions, the issues that have become familiar in our history of rapid growth start to reappear and then reach critical intensity, where safety and economic concerns threaten to force some very hard tradeoffs against system size and flexibility.

Let me just say a few words about some other techniques we are starting to use. One is cross impact analysis. It is a computer assisted technique for estimating event probabilities given occurrence of an event or combination of events. We have a dynamic model that incorporates some of the very same approaches Forrester uses to construct industrial, urban, and even world dynamics models at MIT. Our model was used as a cross check in developing some of the aviation activity estimates in the scenarios. We will soon be developing this model much more extensively. Technology forecasting and assessment techniques also will help us determine the probable developmental paths of technologies which will affect aviation. Right now, a contractor is examining how accelerating trends in mini and microcomputer technology could affect aviation.

These techniques--and others--will be perfected. They will help us prepare contingency plans for the future. They will help us to deal with events that, today, are likely to occur but that are unexpected or unplanned for by all but a very few people. Most will be startled by them and, then, looking back, will kick themselves because they didn't see "the writing on the wall." We will never reach omniscience but we'll be much better off. And we'll do a better job of being prepared. This new activity will also help Gene Mercer do even better in forecasting the future 5 to 10 years out, and I think it will help us all feel more confident about major long-term decisions.

Now let's hear about the forecasts for aviation for the years 1977-88! Duane Freer, Director of the Office of Aviation Policy, will moderate the morning session.

Figure 1

COMPARISON OF PRESENT AND YEAR 2000 LEVELS OF KEY VARIABLES FOR THE FIVE SCENARIOS

KEY VARIABLES	1974	LIMITED GROWTH	MUDDLING THROUGH	RESOURCE ALLOCATION	INDIVIDUAL AFFLUENCE	EXPANSIVE GROWTH
GROSS NATIONAL PRODUCT						
– TRILLIONS OF 1973 DOLLARS	1.3	1.9	2.1	2.9	4.1	4.3
POPULATION						
– MILLIONS OF PEOPLE	212	250	297	250	250	297
BUSINESS PRODUCTIVITY						
– OUTPUT/MAN-HOURS INDEX (1973 DOLLARS)	112	168	161	250	408	354
UNEMPLOYMENT RATE						
– PERCENT	5.6	6.1	8.6	4.8	4.4	5.0
COST OF DOMESTIC CRUDE OIL/BARREL AT THE WELL						
– 1973 DOLLARS	11.0	8.5	14.0	8.0	6.0	7.5
OPERATIONS AT TOWERED AIRPORTS (MILLIONS)						
– AIR CARRIER	12	17	10	17	25	46
– GENERAL AVIATION	43	97	39	105	154	283
– TOTAL OPERATIONS[1]	57	115	52	125	182	333
ENPLANED PASSENGERS						
– MILLIONS	207	406	272	471	788	1,113
TOTAL REVENUE PASSENGER MILES (BILLIONS/YEAR)	131	259	167	304	485	597
AIR CARGO–TOTAL REVENUE TON MILES (BILLIONS OF TON MILES)	3.2	8.3	3.8	9	35	65
JET FUEL CONSUMPTION						
– AIR CARRIER AND GENERAL AVIATION (MILLIONS OF BARRELS)	190	317	158	317	517	850

[1] Total Includes Military

Figure 2

SUMMARY OF MAJOR FINDINGS* BY SCENARIO

	AIR CARRIER TRENDS	GENERAL AVIATION TRENDS	FUEL CONSUMPTION	AIRCRAFT TECHNOLOGY
LIMITED GROWTH	• Small increase in operations. • No new aircraft introduced. • Enplaned passengers increased from 208 million (1975) to 406 million.	• From 72% (1970) to 84% of operations at towered airports. • 95% plus of total aircraft.	• Jet: 65% increase to 317 million bbls/yr. • Avgas: 115% increase to 27 million bbls/yr.	• Low R&D activity except for fuel efficiency. • Stretched versions of existing aircraft.
MUDDLING THROUGH	• Decline in operations. • High load factors. • Enplaned passengers increased from 208 million (1975) to 272 million.	• From 72% (1970) to 75% of operations at towered airports. • Decline in GA ops by 4 million.	• Jet: 17% *decrease* to 158 million bbls/yr. • Avgas: 23% *decrease* to 10 million bbls/yr.	• Low R&D activity. • Only minor changes in existing types of aircraft.
RESOURCE ALLOCATION	• *Small increase in operations.* • Enplaned passengers increased from 208 million (1975) to one-half billion.	• *From 72% (1970) to 84% of* operations at towered airports. • 95% plus of total aircraft.	• Jet: 65% increase to 317 million bbls/yr. • Avgas: 115% increase to 28 million bbls/yr.	• Moderate R&D activity, concentrating on fuel efficiency and noise reduction.
INDIVIDUAL AFFLUENCE	• 100% increase in operations. • Enplaned passengers increased from 208 million (1975) to 800 million. • STOL and Super turbojets.	• From 72% (1970) to 85% of operations at towered airports. • 95% plus of total aircraft.	• Jet: 169% increase to 517 million bbls/yr. • Avgas: 154% increase to 33 million bbls/yr.	• High levels of technology tempered by environmental concerns. • Fewer new aircraft than *Scenario 5*
EXPANSIVE GROWTH	• 300% increase in operations. • Enplaned passengers increased from 208 million (1975) to 1 billion. • Jet STOL, Super large, and SST aircraft.	• From 72% (1970) to 85% of operations at towered airports. • 95% plus of total aircraft.	• Jet: 342% increase to 850 million bbls/yr. • Avgas: 423% increase to 68 million bbls/yr.	• Rapid development of new aircraft. • Heavy emphasis on R&D.

*Unless otherwise stated all figures shown are for the year 2000.

Figure 3

SUMMARY OF MAJOR FINDINGS* BY SCENARIO

	AIR TRAFFIC CONTROL TECHNOLOGY	COMPLEMENTARY AND COMPETING MODES	AIR CARGO	AVIATION SAFETY
LIMITED GROWTH	• UG3rd installation began in 1985. • NAS rate of growth reduced.	• Auto intercity travel declines. • Shift from auto divided between air, rail and mass transit.	• Low growth (less than 3%) due to weak economic conditions.	• Relatively low demand. • Decline in rates and number of accidents.
MUDDLING THROUGH	• Little change in NAS from 1970's.	• Increased telecommunications substituted for travel.	• Low growth (+2%) then decline due to economic conditions.	• Demand less than system capacity, resulting in • Fewer accidents.
RESOURCE ALLOCATION	• UG3rd in 1985. • 4th generation ground-based ATCS by 2000.	• Auto intercity travel declines. • High speed ground intercity transit.	• Moderate growth (+4%).	• Relatively low rate of increase in demand, and • Increased use of technology in NAS, *results in*, • Decline in rates and number of accidents.
INDIVIDUAL AFFLUENCE	• UG3rd by 1980. • 4th generation ground-based ATCS by 1990.	• Auto retains major role. • High speed ground intercity transit.	• High growth (+9%). • *All-cargo flights increased.*	• Technological and procedural advances, but • No decline in numbers of accidents, because of • Heavy increase in aviation activity.
EXPANSIVE GROWTH	• *Automated air-based* ATCS by 1990.	• *Auto retains major role.* • High speed ground intercity transit.	• *Very high growth* (+12%). • All cargo airports in 1990's.	• Improved technology and operating procedures. • Number of accidents and fatalities do not decline because of high demand.

*Unless otherwise stated all figures shown are for the year 2000.

HIGHLIGHTS OF 1977-1988 AVIATION FORECASTS

- Gene S. Mercer
Chief, Aviation Forecast Branch, FAA

Aviation Forecasts are the driving force behind FAA planning. This means that the plans for the future of the national aviation system are a function of the forecast aircraft activity levels which, in turn, are driven by estimated national economic conditions. The assumptions as to the future course of the economic variables deserve special attention. As all forecasters realize, the assumptions are a critical part of any forecast method. Unforeseen circumstances may confound the most carefully formulated forecasting effort. This is more important, of course, as we extend the time horizon of the forecasts.

ECONOMIC ASSUMPTIONS

The economic outlook utilized for the aviation forecasts, 1977-1988, may be characterized by short-term optimism modified by more cautious overtones for the more distant future. The overall outlook is for moderate economic growth, declining unemployment, and decelerating inflation rates.

Figure 1 shows our assumptions about real GNP in billions of constant 1972 dollars.

The declines in real gross national product experienced during 1974 and 1975 have been turned around, and a growth of about 6.2 percent is expected for real GNP during 1976 with an additional 5.1 percent growth for 1977. Significantly lower growth rates for real GNP are used for the more distant future. The average annual growth for real GNP for the forecast period is about 3.3 percent--from $1,168 billion in 1975 to about $1,800 billion in 1988. As a point of reference, this year's assumed growth rate in real GNP is lower than the 4.2 percent that we used last year.

Figure 2 shows our assumed values for real personal disposable income per capita in 1972 dollars. Real personal disposable income, which declined by 3.4 percent and 2.2 percent during 1974 and 1975, respectively, is expected to grow by 6.4 percent during 1976 and by less than 1.0 percent during 1977. The $4,280 real personal disposable income forecasted for 1976 is 3.2 percent higher than that used in last year's forecast and is reflective of our short-term optimism. Except for 1982, annual increases in the range of 1.0 percent to 4.0 percent are expected for all subsequent years. An average annual increase of about 2.3 percent is expected in real personal disposable income over the forecasted period. Last year we assumed a 3.0 percent growth. This difference is reflective of our more cautious outlook for the distant future.

Figure 3 shows our assumed rate of price increases as measured by the GNP deflator. Inflation rates of over 11.0 percent and almost 9 percent experienced during 1974 and 1975, respectively, are estimated to slow to around 5.1 percent in 1976 and 6.1 percent during 1977. Significantly higher rates (about 7.5 percent) are assumed for 1978 through 1980, followed by rates of inflation around 5.3 percent through 1988. The average annual inflation rate for the forecast period is 6.2 percent. Last year we assumed a 6.5 percent annual inflation rate for our forecasts.

Figure 4 shows our assumptions for the unemployment rate. An unemployment rate of 7.7 percent was assumed for 1976, declining to 6.4 percent in 1977. For the remainder of the 70's we envision unemployment rates of about 5.4 percent. The unemployment rate for the 80's is expected to hover around 4.6 percent.

HINDSIGHT

As you may know, our economic assumptions and our aviation forecasts must be finalized as of July each year. Around the end of the year we inevitably must deal with hindsight criticisms about one or another of our forecasts. If we had the option of periodically updating our forecasts, as most national forecasting services do, we could, of course, reduce forecasting error generated by changes in circumstances external to aviation. Because of the budget cycle and other internal planning purposes, we do not have that luxury. In July our economic assumptions, which were based on the Wharton

Econometric Associates forecasts, were in general fairly pessimistic, especially beyond 1977, compared to those put forth by other forecasting services. However, the movement of the economic indicators since July tends to reaffirm our foresight. A term frequently used to describe the current state of the economy is "pause"--the economy is in a pause. Current economic thinking is that this pause or lull may well last into next year. Thus, most of the nation's leading forecasters have scaled down their estimates of economic growth for 1976. This is shown in Figure 5. For example, Manufacturers Hanover Trust's fourth quarter CY 1976 growth in real GNP is currently estimated at an annual rate of 1.2 percent, down from their earlier forecast of 5.5 percent. Other forecasters are less pessimistic. For example, Chase Econometrics is now forecasting 5.8 percent in real growth during the fourth quarter as opposed to their earlier forecasts of 6.5 percent. The Wharton Econometric Associates' forecast remains unchanged at 5.2 percent real growth for this period.

Given the fact that the economic assumptions and the aviation forecasts were finalized in July, and given the continuance of the economic lull, the question most relevant to the forecasts is: Will the recovery die? We think not! Even in hindsight, there is no visible evidence of excesses in the field of inventory stocks or dangerous avalanches of bankruptcy and illiquidity that make a genuine recession--or even a growth recession--all but inevitable. None of the major forecasters predict that the slowdown will deteriorate into another recession. Indeed, some of the revised forecasts for CY 1977 are more optimistic than the earlier forecasts. This is shown in Figure 5. For example, DRI (Data Resources, Incorporated) has increased its CY 1977 growth in real GNP from 5.3 percent to 5.7 percent, and Wharton from 4.5 percent to 5.4 percent. Other forecasting services--for example, Manufacturers' Hanover and Chase, mentioned earlier--are currently more pessimistic than their earlier forecasts. However, regardless of their degree of optimism or pessimism, all forecasting services agree that there will be some real growth, and there will not be a decline in real GNP, as was experienced during 1974 and 1975.

NEW ADMINISTRATION

Finally, the question we must face, and inevitably someone will ask: What effect will the new administration have on the forecasts, and/or did we build a Carter/Ford assumption into the aviation forecasts? The answer is that we did not explicitly or intentionally try to anticipate the results of the elections. Since we prefer to wait until we have more specific information about the plans and programs of the Carter Administration, we do not want to suggest any revisions of our forecasts at this time.

Forecasts

This year's Aviation Forecast includes three long-term forecasts. A baseline forecast for 1977 through 1988 is presented on a year-by-year basis. In addition, a high and a low scenario, showing possible impacts of different economic conditions, are presented for FY 1988.

Two new forecasts have been added this year dealing with air cargo and the military fleet size. The air cargo forecast is for domestic and international revenue cargo ton-miles and revenue tons enplaned. The military forecast is for the number of aircraft stationed within the continental United States. The forecast is subdivided by engine type and by fixed-wing aircraft and helicopters.

Figures 6 and 7 are presented as a general overview of this year's forecasts. In addition they present a comparison with last year's forecast across selected activity measures (see Figure 6).

The decrease in total operations during the forecast period is attributable primarily to lower forecasts of local operations compared to those made in September 1975. Specifically, general aviation local operations are about 5 percent lower in 1978 and the discrepancy is somewhat greater in later years. This is attributable to lowering our growth assumptions of per capita income. Air carrier itinerant operations are also lower (6 to 7 percent in later years). The number of air taxi itinerant operations is higher in the present forecast than that shown in the September 1975 forecast.

The increase in the instrument operations forecast in the near term over last year's forecast is due to expected increases for general aviation and air taxi. Additionlly, 14 new airports have commissioned Stage III of expanded area radar service. Current air carrier instrument operations forecasts are lower than last year's forecasts (5 to 7 percent lower for each of the forecast years).

The present forecasts of total IFR aircraft handled are quite close to those indicated in September 1975. Increases in general aviation and air taxi IFR aircraft handled are offset, for the most part, by decreases in the forecasts of air carrier IFR aircraft handled.

Current forecasts for all elements comprising total flight services are lower as compared to last year's forecasts. Numerically, the largest differences occur in the forecasts of pilot briefs. This, as well as the weights employed in the computational procedures, cause pilot briefs to be the major contributor to the decline in the forecast of total flight services.

It should be noted that the fiscal year forecasts for 1977 and beyond are based on the new fiscal year period, October 1 through September 30.

Figure 8 reflects tower operations which are forecast to have an average yearly growth rate of 4.6 percent through FY 1988. Twelve new towers added to the system in FY 1976 accounted for a substantial proportion of the increase in total and general aviation activity. The addition of these towers in FY 1976 combined with the impact of economic recovery resulted in a 5.9 percent increase in total tower operations over the FY 1975 total.

Like total aircraft operations, instrument operations, Figure 9, at FAA towers are expected to increase in the years ahead. Further implementation of Terminal Control Areas and Stage III of expanded radar service is not anticipated after FY 1976. General aviation is expected to continue past trends and increase its use of sophisticated avionics equipment. Consequently, the general aviation category of instrument operations will grow at an average 7.0 percent annual rate through FY 1988. Total instrument operations are forecast to increase at a 4.8 percent annual growth rate.

Figure 10 depicts the growth of activity at centers by user category. The reasons for forecasting an increase in activity at air route traffic control centers are similar to those for instrument operations. In the future, general aviation and air taxi operations will have an increasing impact on center workload. As an example, general aviation IFR aircraft handled are expected to grow at a 6.9 percent rate per year through FY 1988. Complementing this growth is an expected 3.1 percent annual growth rate in air carrier aircraft handled and no growth in military activity.

The forecast breakdown of total flight services is shown in Figure 11. Historically, flight service stations have provided the greatest share of their flight services to general aviation. The basic workload measure for the flight service stations is the number of flight services which is a weighted measure of aircraft contacted, flight plans originated, and pilot briefs. During the period from FY 1976 to FY 1988 total flight services are forecast to increase from 58.2 million to 120.1 million, a 106 percent increase over FY 1976.

Our next speaker, Bernard Hannan, will now cover air carrier forecast.

FIGURE 1

GROSS NATIONAL PRODUCT
(1972 DOLLARS)

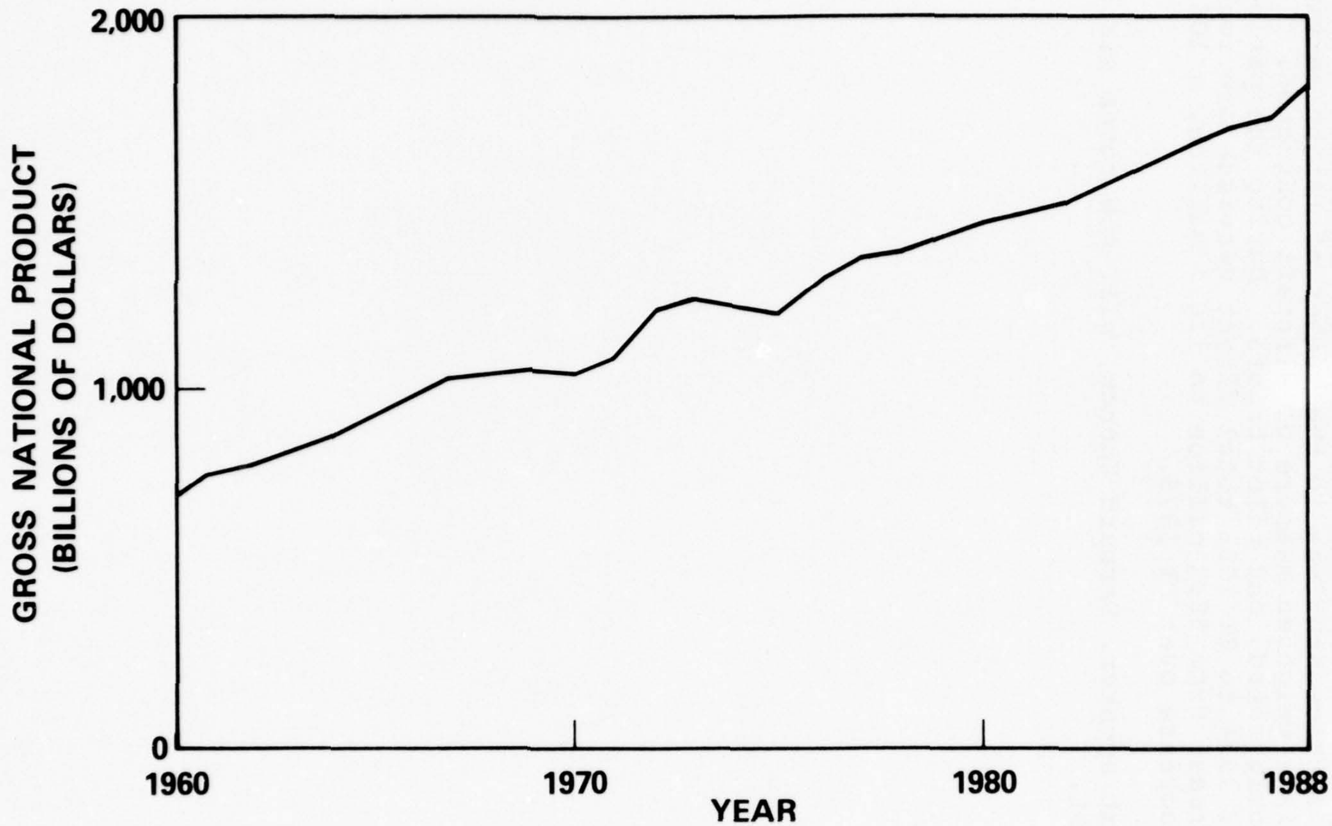


FIGURE 2

PERSONAL DISPOSABLE INCOME PER CAPITA (1972 DOLLARS)

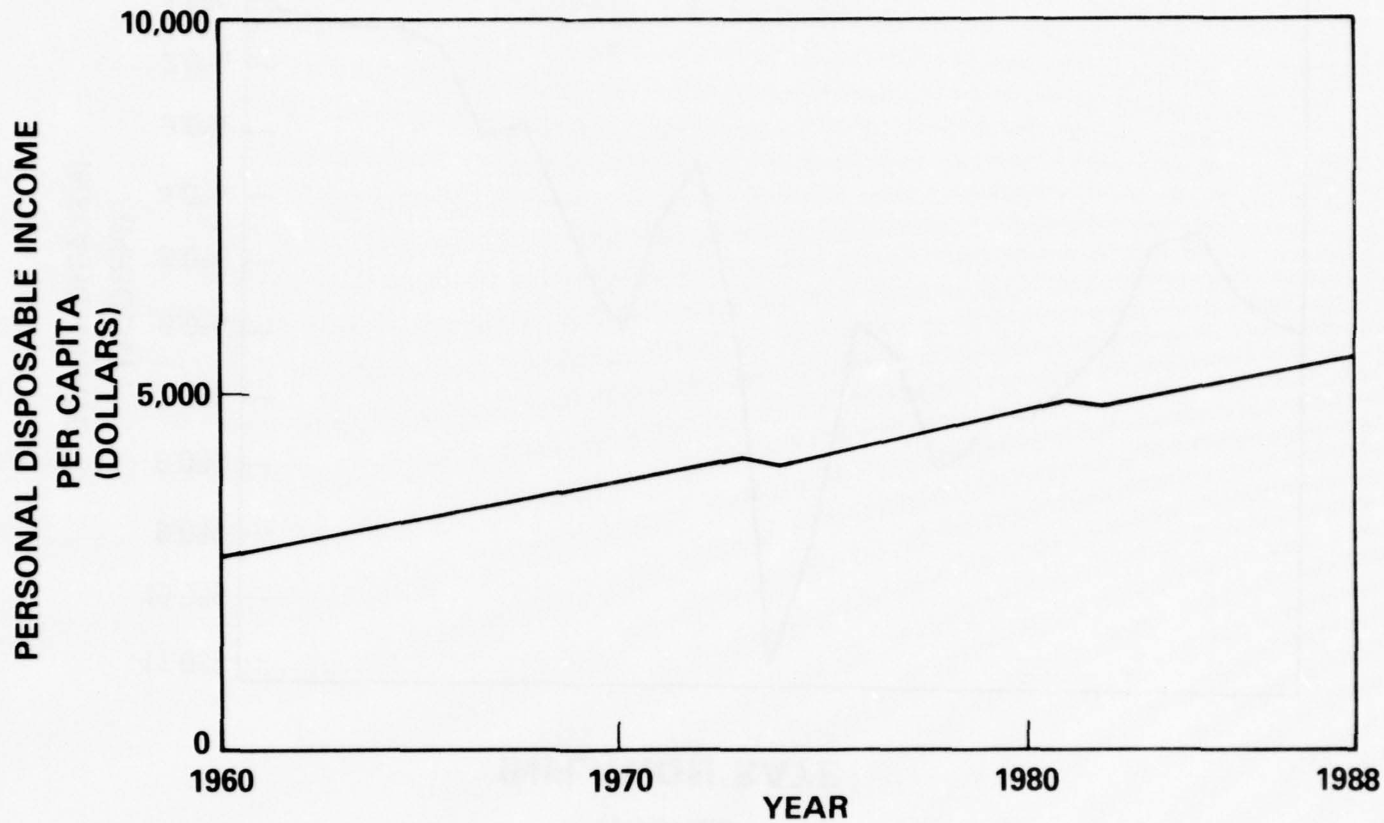


FIGURE 3

INFLATION RATE

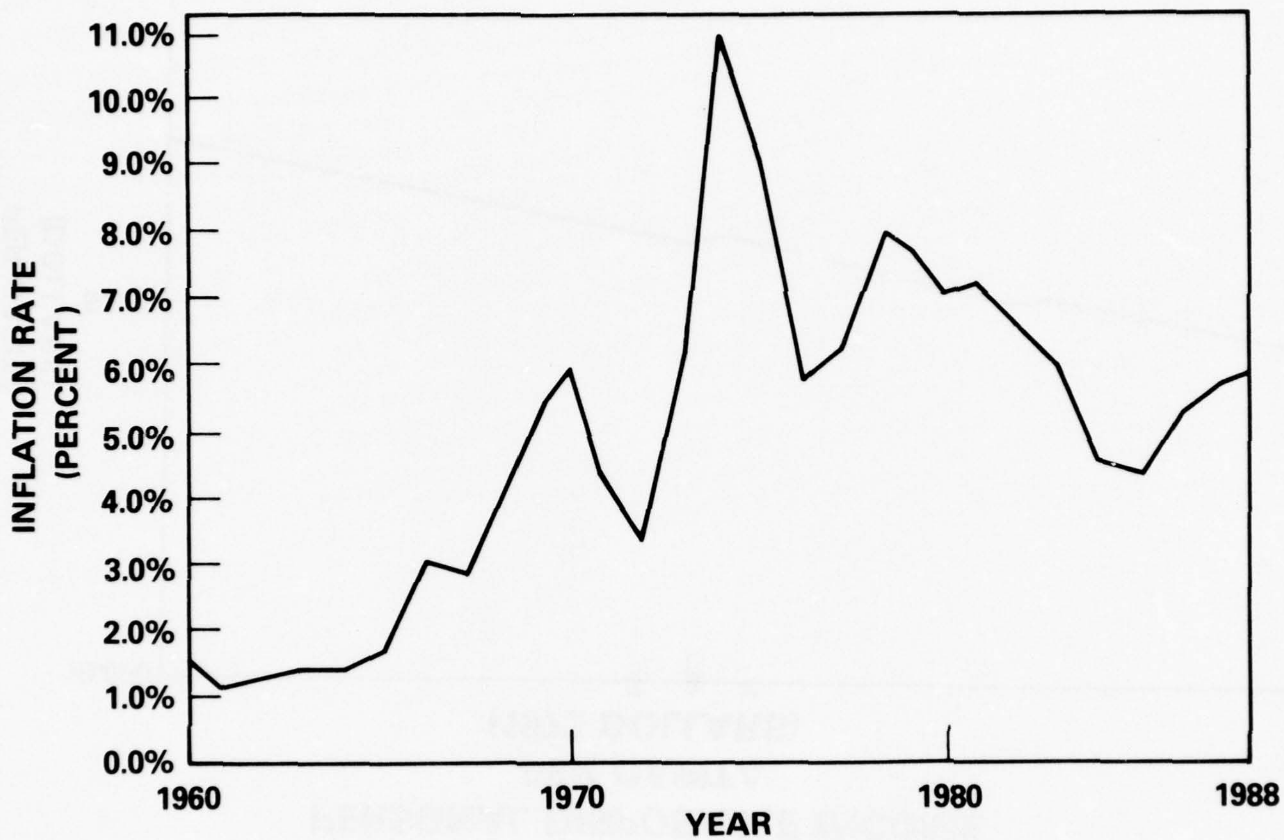


FIGURE 4

UNEMPLOYMENT RATE
PERCENT OF TOTAL LABOR FORCE

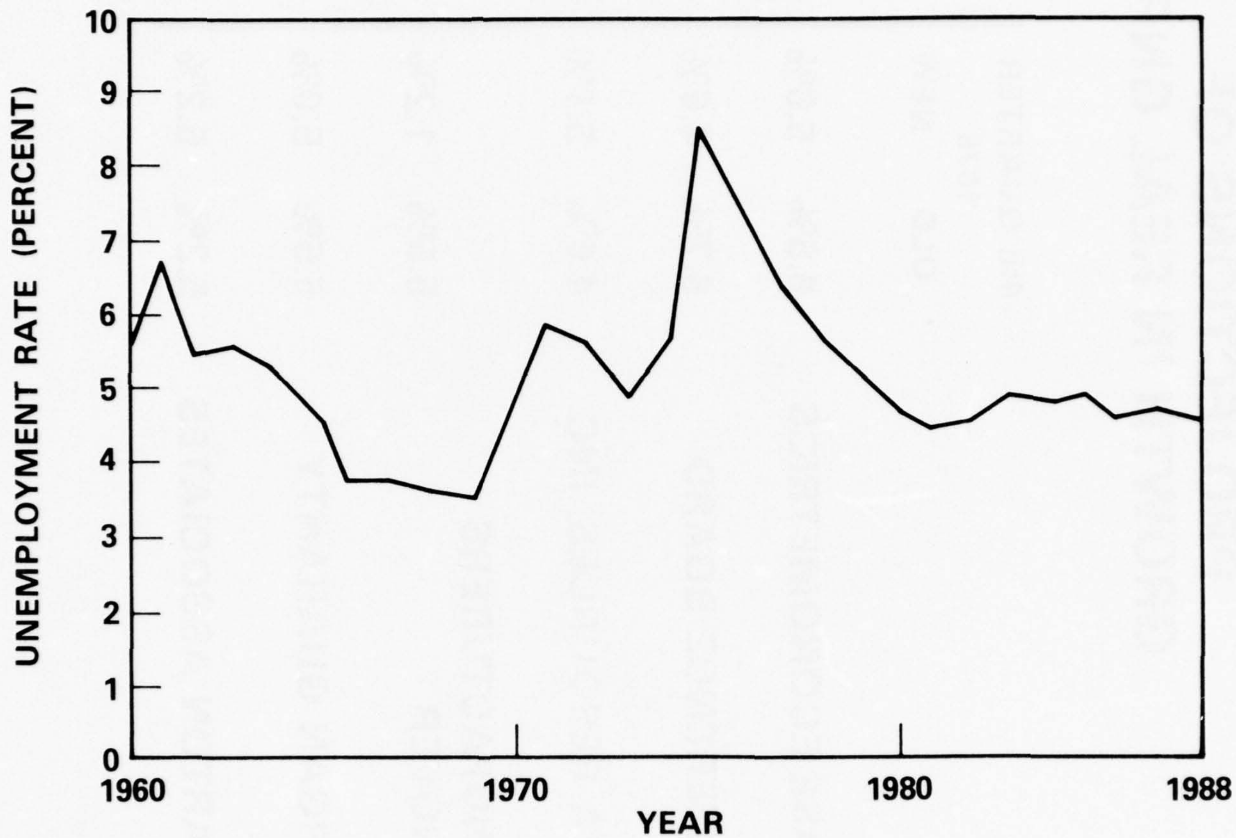


FIGURE 5

PROJECTIONS OF GROWTH IN REAL GNP

	4th QUARTER 1976		1977	
	OLD	NEW	OLD	NEW
CHASE ECONOMETRICS	6.5%	5.8%	4.8%	4.7%
CONFERENCE BOARD	6.7%	4.6%	5.2%	5.4%
DATA RESOURCES, INC.	4.6%	5.1%	5.3%	5.7%
MANUFACTURERS HANOVER	5.5%	1.2%	5.0%	3.3%
MORGAN GUARANTY	5.5%	5.0%	5.5%	5.0%
WHARTON ASSOCIATES	5.2%	5.2%	4.5%	5.4%

FIGURE 6

FORECAST COMPARISONS

SEPTEMBER 1976 VERSUS SEPTEMBER 1975

	TOWER OPERATIONS (IN MILLIONS)			INSTRUMENT OPERATIONS (IN MILLIONS)		
ACTUAL	1976	1975	PERCENT CHANGE	1976	1975	PERCENT CHANGE
1976	62.5			28.1		
FORECAST						
1977	66.6	65.9	+ 1.1	30.9	28.6	+8.0
1987	103.4	124.8	−17.1	47.8	50.9	−6.1

FIGURE 7

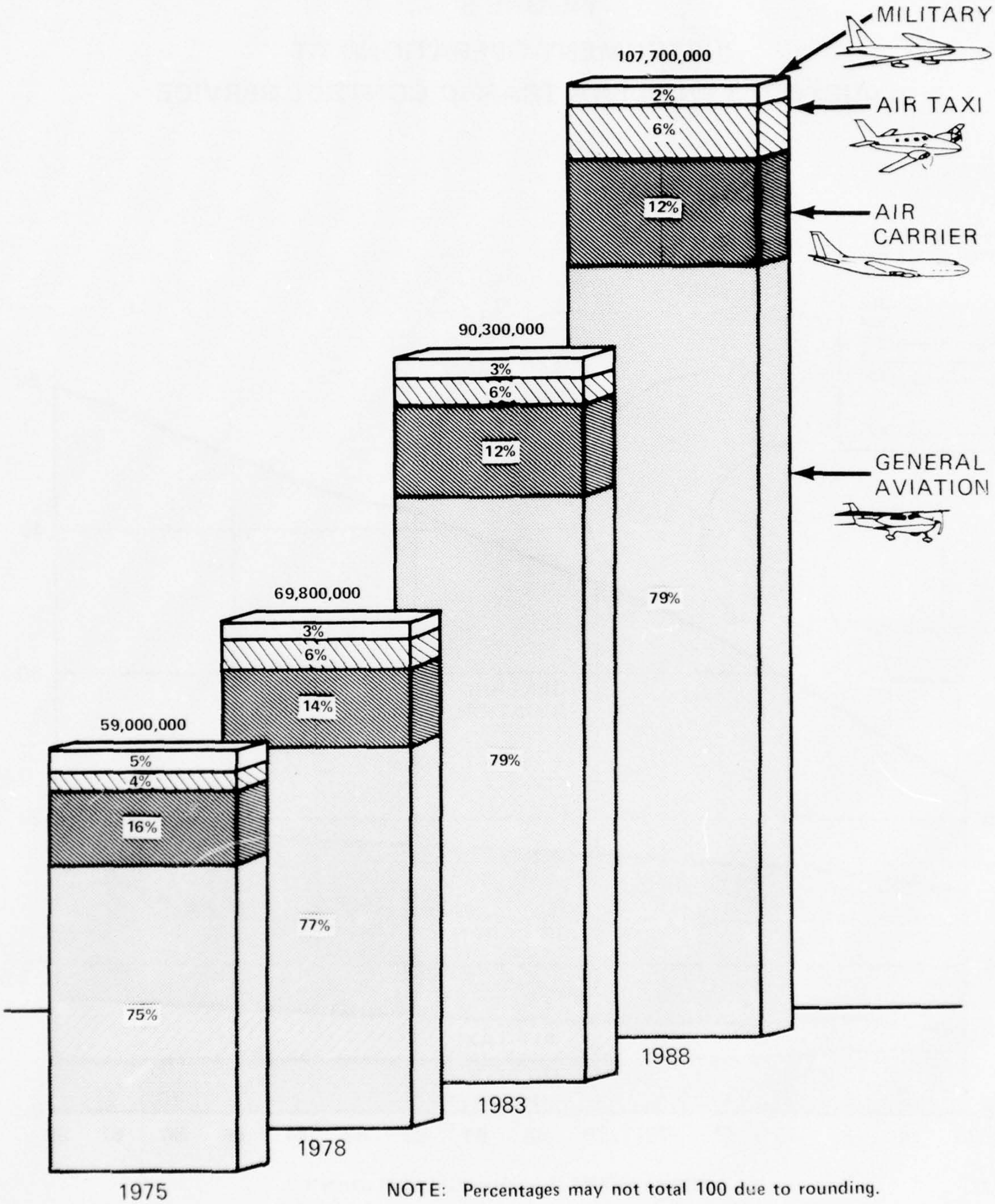
FORECAST COMPARISONS

SEPTEMBER 1976 VERSUS SEPTEMBER 1975

	IFR AIRCRAFT HANDLED (IN MILLIONS)			FLIGHT SERVICES (IN MILLIONS)		
ACTUAL	1976	1975	PERCENT CHANGE	1976	1975	PERCENT CHANGE
1976	23.9			58.2		
FORECAST						
1977	25.7	25.6	+0.4	65.6	72.9	−10.0
1987	37.7	39.4	−4.3	114.7	143.6	−20.1

FIGURE 8

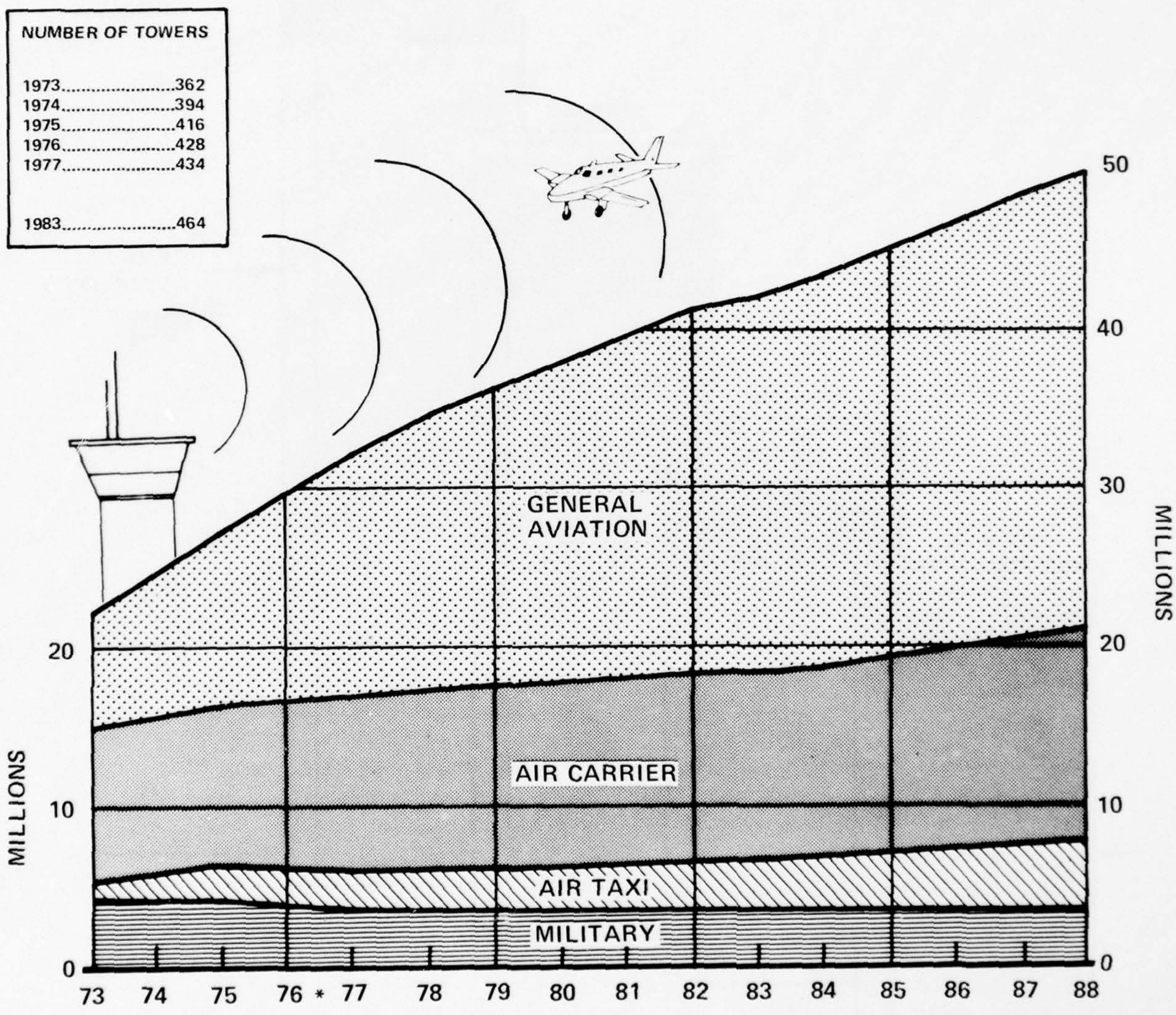
TOTAL AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE



NOTE: Percentages may not total 100 due to rounding.

FIGURE 9

INSTRUMENT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE



FISCAL YEARS (*indicates transitional quarter)

FIGURE 10

IFR AIRCRAFT HANDLED BY FAA AIR ROUTE TRAFFIC CONTROL CENTERS

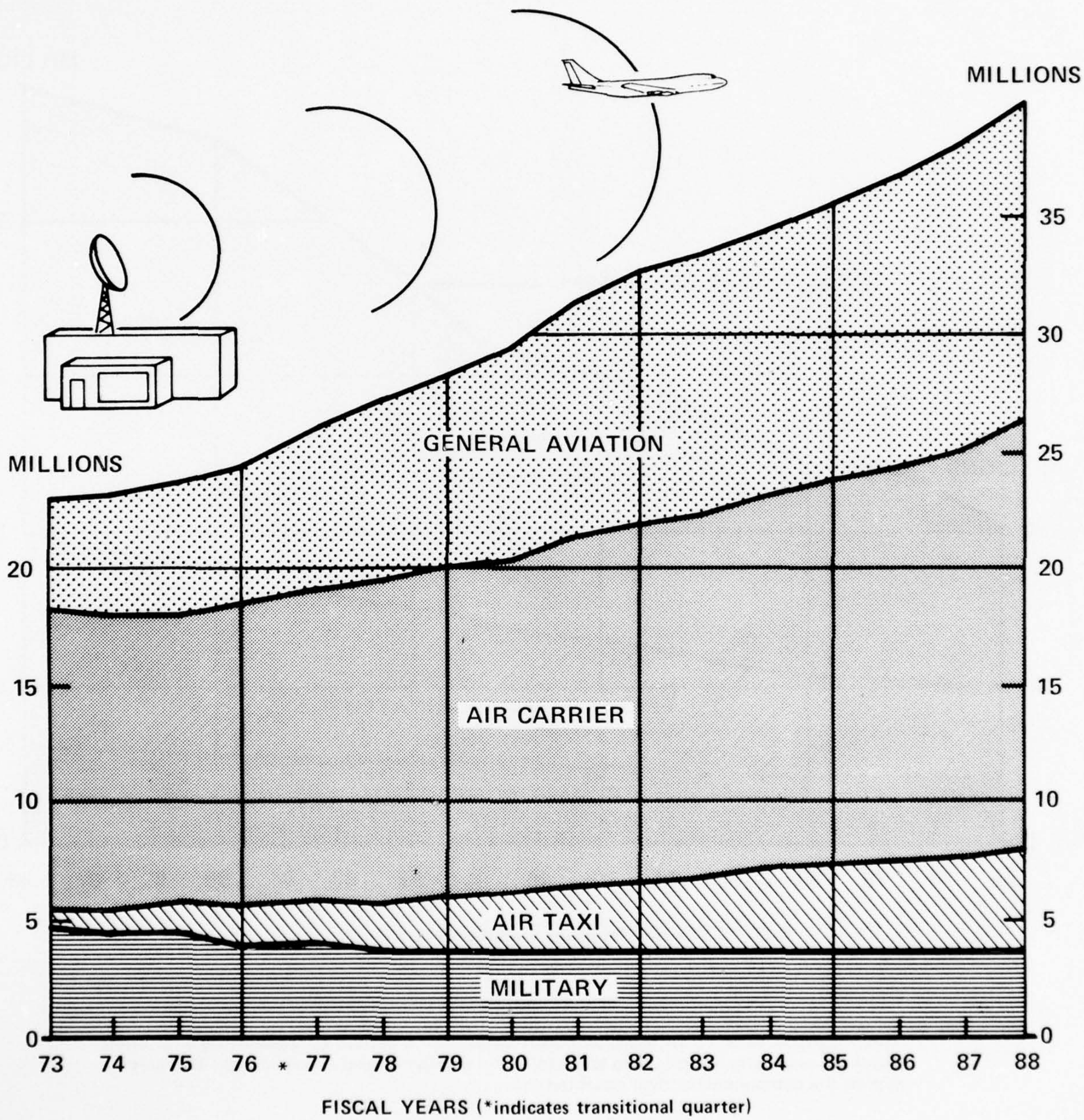
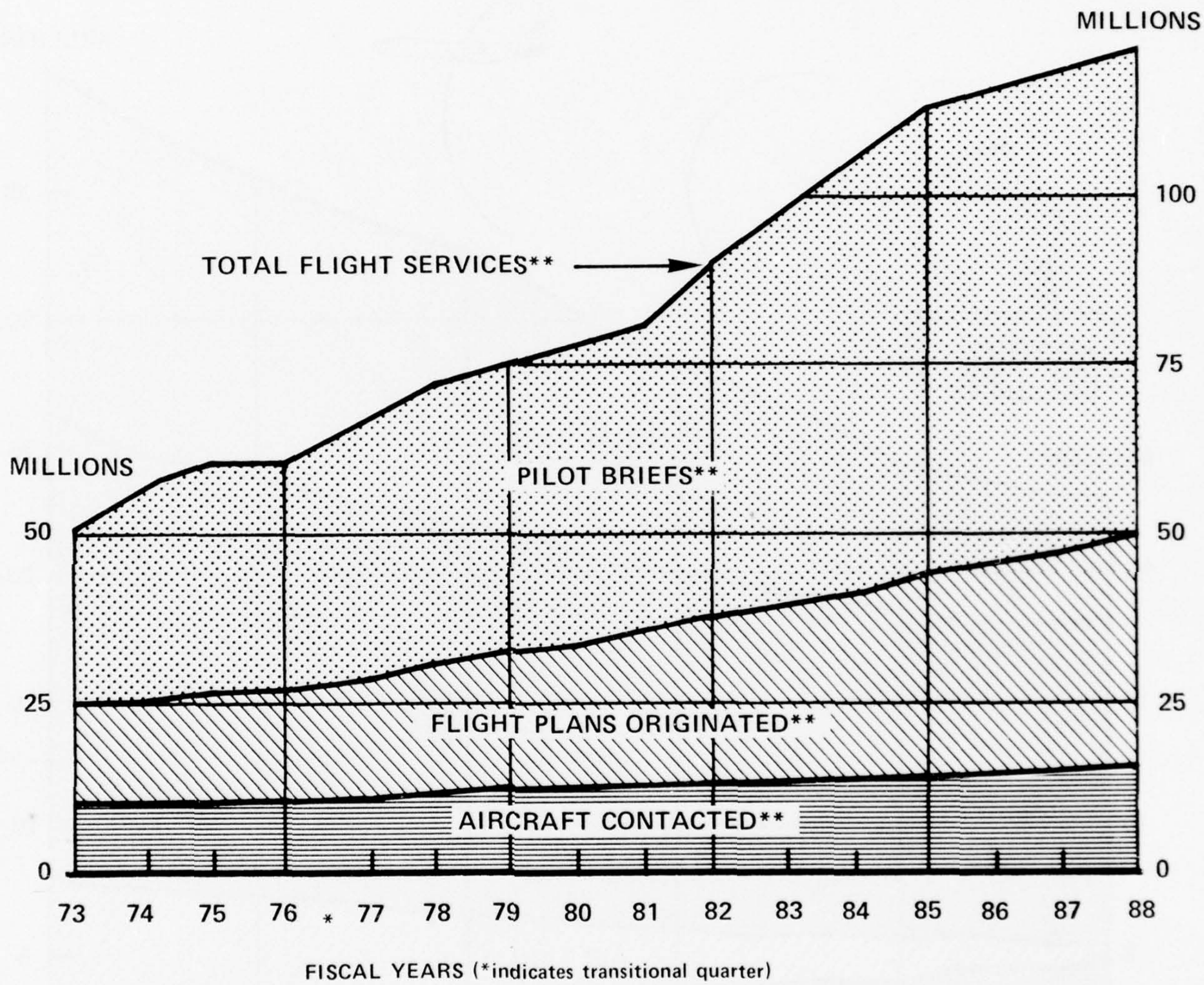


FIGURE 11

TOTAL FLIGHT SERVICES AT FAA FLIGHT SERVICE STATIONS AND COMBINED STATION/TOWERS



** Total Flight Services is a weighted workload measurement derived by multiplying pilot briefs and flight plans originated by two and adding the number of aircraft contacted. This graph depicts the components in their weighted form.

AIR CARRIER PRESENTATION

- Bernard Hannan
  Transportation Analyst, FAA

Good Morning. I will be talking to you today about the air carrier portion of the FAA forecasts.

The FAA definition of an air carrier is simply "Any operator of large aircraft that transports passengers or cargo for hire."

In Figure 1, you can see the groupings into which the FAA divides the air carrier industry when preparing its forecasts. These groupings are slightly different from the Civil Aeronatics Board's (CAB) and I will explain the differences as I go along. The chart also shows the number of operators in each group and the number of aircraft each group operates.

The trunk carriers include airlines such as American and Pan American. There are 11 trunk carriers and they operate 1,716 aircraft. The FAA local service carrier group includes the CAB designated local service carriers, Hawaiian carriers, Alaskan carriers and a group that the CAB classifies as "other." We have included all these carriers in one group because they offer similar service and operate similar types of equipment. There are 17 carriers in this group and they operate 496 aircraft. There are three carriers in the all cargo area: Flying Tigers, Seaboard World and Airlift International. They operate 37 aircraft. Last year there were three helicopter operators when we did our forecast. This year there were two operators who operated seven helicopters when our forecasts were accomplished. Today there is one operator who operates four helicopters. The helicopter operators included in the air carrier forecasts are only those certified by the CAB. The supplemental carriers include airlines such as World and Overseas National. They are charter airlines who operate most of their service between the United States and points outside the 48 mainland states. There are eight of these carriers and they operate 75 aircraft. The intrastate carriers include operators such as PSA and Air Florida. They are not regulated by the CAB, but are regulated by the states in which they operate. There are five of these carriers and they operate 48 aircraft. The commercial carriers are usually contract carriers such as Zan Top, which deals mostly with the automobile manufacturers carrying auto parts, and Alaskan International which operates Hercules transports in support

of the oil drilling and pipeline building operations in Alaska. There are 23 commercial carriers and they operate 127 aircraft. They are not regulated by the CAB. The last group of air carriers are the travel clubs such as the Emerald Schillelagh Chowder and Marching Society, Inc. and the Atlanta Skylarks. There are 13 of these carriers, and they operate 17 aircraft. They also are not regulated by the CAB.

The operations at FAA towered airports and air route traffic control centers by these 82 carriers operating 2,523 aircraft, along with the foreign air carriers that serve FAA towered airports are the ones that the FAA includes in its air carrier forecasts.

Before we review our forecasts, I would like to review the results of FY 1976. The air carrier industry, following the trend of the nation's general economy, experienced a 7.5 percent increase in domestic scheduled revenue passenger-miles (see Figure 2). In the international area the recovery was not as strong. Revenue passenger-miles increased by slightly less than three percent while international passenger boardings on United States carriers actually decreased by one percent.

Air cargo, which includes freight, express and mail, increased by five percent during FY 1976. Domestic air cargo revenue ton-miles increased by four percent while international cargo revenue ton-miles increased by six percent.

Fuel prices continued to rise for domestic and international air carriers during FY 1976 (see Figure 3). In June of 1973, the average price of fuel was 12.5 cents per gallon for the total industry. By June 1976, the average industry price had increased to 31.0 cents per gallon. As a percent of total airline operating costs, fuel had risen from 12 percent in 1973 to approximately 20 percent in 1976.

For FY 1976, the operating profit for the total air carrier industry was $333 million, a 19 percent increase above the $281 million profit reported for FY 1975 (see Figure 4). However, the improvement was due entirely to an increase in the operating profit of the international carriers which reported a $30 million profit in FY 1976 after reporting a $36 million loss in FY 1975. The operating profit of domestic carriers decreased from $316 million in FY 1975 to $303 million in FY 1976.

It might be interesting to look at what has happened to the air carrier industry operating profits since 1960. As you can see, with the introduction of the jets in the early 1960's coupled with a very healthy growth rate in air travel, the air carriers operating profits soared to a peak of $800 million in 1965 (see Figure 5). In FY 1967, however, since the carriers were still investing heavily in new aircraft, an overcapacity problem began to develop. The increase in traffic that the new aircraft were bought to handle did not occur to the extent it had been forecast because of a slowing in the growth of the general economy. Air carrier operating costs were also escalating during this period while yield per RPM was decreasing. Because of these factors the air carriers suffered a $30 million loss in operating revenues in FY 1971. The carriers at this time cut their operations and increased their load factors so that by FY 1974, their operating profit had again reached $800 million. At this point fuel prices began increasing at a substantial rate and when added to another slowdown in the general economy led to a drop in air carrier profits to $200 million in FY 1975.

In Figure 6, we can see the results of operating profit versus total revenues. Dr. McLucas spoke about this point earlier. Because air carrier revenues have been growing continuously, the amount of operating profit per dollar of revenue has decreased substantially. As you remember the operating profits in 1966 and 1974 were nearly equal. However, the profit per dollar of revenue for these two years decreased from 16 cents to six cents. When we consider that a new 145 seat 707 or DC-8 cost approximately $7 million in the mid-1960's while a new 250-seat DC-10 or L-1011 costs between $25 and $30 million today, we begin to understand part of the reason for the decrease in the number of new aircraft on order we see today. As an example, on January 1, 1970, the U.S. air carriers had 368 aircraft on order with a value of $5.5 billion (see Figure 7). By 1973 this had dropped to 267 aircraft valued at $3.6 billion. As of the first of this year the aircraft on order had dropped to 123 aircraft valued at $1.7 billion. One other very important point is that almost all of these aircraft on order today are standard body jets. Today, not counting options, there are only nine L-1011's on order by U.S. carriers, one 747, a freighter, and no DC-10's. These aircraft are the newest technology aircraft that our aircraft manufacturers are now building. They are the larger capacity aircraft which are to a major extent expected to add the capacity needed to carry the expected growth in air travel without adding large increases in operations. If growth increases are absorbed by adding more operations rather than using

larger aircraft, capacity problems will increase at our airports and in the air traffic control system. We know that one reason for the discontinuing of wide body aircraft orders was the overcapacity problems that resulted in the early 1970s when air travel did not grow to the levels expected. However, the average domestic passenger load factor for Fiscal Year 1976 reached 55.5 percent which would appear to demonstrate that the airlines may in the near future be experiencing a shortage of capacity to handle the expected air travel demand.

Now let us look at what the FAA has forecast for air carrier operations. The methods and the several forecasting models that we employ are discussed in the main body and the appendix of our Aviation Forecasts. This afternoon in the air carrier portion, we will be discussing methods used for forecasting international operations and air cargo growth.

Basic underlying assumptions for all our forecasts include:

- A continuing of the economic recovery into 1978 and continued modest growth beyond.
- The supply of energy and fuel will not significantly inhibit economic or aviation growth, although prices are expected to increase throughout the forecast period.
- The basic trends in the air carrier industry and its service patterns which have evolved over the years will continue without substantial change.
- No economic or procedural changes will significantly inhibit the growth of aviation.
- No operational constraints such as additional curfews are reflected.

We have forecast a growth in domestic RPM's from FY 1976's 137 billion to 289 billion in 1988 for an average growth rate of 6.4 percent per year (see Figure 8). In the international area RPM's are forecast to grow from 32 billion to 73 billion in 1988 for an average growth of slightly more than 7 percent per year. These forecasts of RPM's are for scheduled passenger traffic.

We are forecasting domestic air cargo ton-miles to increase from four billion in FY 1976 to eight billion by 1988. International cargo ton-miles are forecast to increase form six billion to 17 billion in 1988.

After we have completed our RPM and cargo forecasts, we then develop an air carrier fleet and operations forecast. In order to do this, we first talk to all the major aircraft manufacturers and as many airlines from all groups as time will permit.

The assumptions that we have made dealing with equipment are that:

- Stretch versions of present twin engine standard body jets will continue to be introduced into the fleet.

- At least one new aircraft with a seating capacity between the 727-200 and the wide-body trijets will be introduced in the early 1980's.

- Stretch versions of the present wide-body trijets will appear in the early 1980's.

- Retirement of nonfan and older fan-jet aircraft will continue during the forecast period.

For seating capacity we assumed:

- Continued decrease in the size of the first class section which will result in an overall increase in aircraft seating.

- The number of seats abreast will increase by one in all wide-body jets in the next several years.

Load factors will increase from the present 55 percent to 58 percent by the early 1980's. Using these assumptions, we forecast the air carrier fleet to grow from 2,523 aircraft in 1976 to 3,500 by 1988 (see Figure 9). As you can see, all of the growth will take place in the pure jet area. This piston and turboprop fleet will continue to decrease during this period. As far as total airborne hours are concerned, they are forecast to increase from 6.1 million to 8.3 million in 1988.

If we compare the air carrier fleet size and airborne hours to the total aviation community, we will see that the air carrier fleet represents 1.3 percent of the total active aircraft. However, because of their comparatively high utilization rate the air carriers produce 13 percent of the hours flown. By 1988 the air carrier fleet will represent 1.2 percent of the total fleet and they will produce 10 percent of the hours flown (see Figure 10).

Now, how do these increases affect the FAA. The FAA provides the aviation community with three distinct operational services: First, air traffic control at selected airports (these include all airports that receive air carrier service except for some isolated airports such as those in the sparsely populated areas of the northern boarder states and Alaska); secondly, enroute traffic control; and lastly, flight services, which include such services as pilot briefings and flight plan filings.

The air carriers use of the FAA flight service facilities is so slight that they are not shown as part of these forecasts. Therefore, the air carriers are dealt with in the remaining two areas.

Total operations at airports with FAA traffic control towers amounted to 62.5 million in FY 1976. The air carriers accounted for 9.3 million or 15 percent of the total. By 1988 air carrier operations are forecast to increase to 13.2 million, a 42 percent increase. However, because of the faster growth in general aviation operations, the air carriers will then account for 12 percent of the total (see Figure 11). Total airport operations are broken down into local operations (taking off and landing at the same airport and staying within 25 miles of the airport) and itinerant operations (taking off at one airport and landing at another). The air carriers for all intents and purposes do no local flying. Therefore, their airport operations are almost all itinerant operations. In FY 1976 the air carriers accounted for 23 percent of the itinerant operations at FAA controlled airports. By 1988 this will decrease to 20 percent. In dealing with IFR aircraft handled at FAA air route traffic control centers, the air carriers are the largest user of this service today and will continue to be in the foreseeable future. In 1976 the FAA handled 12.4 million air carrier operations at its centers and this accounted for 52 percent of the total. By 1988 air carrier aircraft handled are forecast to increase to 17.8 million or 45 percent of the total (see Figure 12).

One other factor should be noted at this time. We have recently seen two commuter carriers receive certificates as air carriers from the CAB. Our air carrier forecasts do not include any additional commuters in the air carrier group. However, the air taxi forecast assumes no loss of commuter carriers. Therefore, the total FAA forecast includes all carriers.

This concludes our discussion of the FAA air carrier forecasts. We will be happy to answer at this time any questions on this subject, or the overall aviation forecasts that were covered earlier.

Figure 1

AIR CARRIERS

	No. of Carriers	Fleet Size
Trunk	11	1,716
Local Service	17	496
All Cargo	3	37
Supplemental	8	75
Helicopter	2	7
Intra-State	5	48
Commercial	23	127
Travel Clubs	13	17
Total	82	2,523

Figure 2

SCHEDULED PASSENGER TRAFFIC

Fiscal Year	Revenue Passenger-Miles (Billions) Total	Domestic	International
1975	159.0	127.7	31.3
1976	169.5	137.3	32.2
Percent Increase	6.6	7.5	2.9

Figure 3

AIR CARRIER FUEL EXPENSES: COST PER GALLON AND PERCENTAGE OF TOTAL COSTS

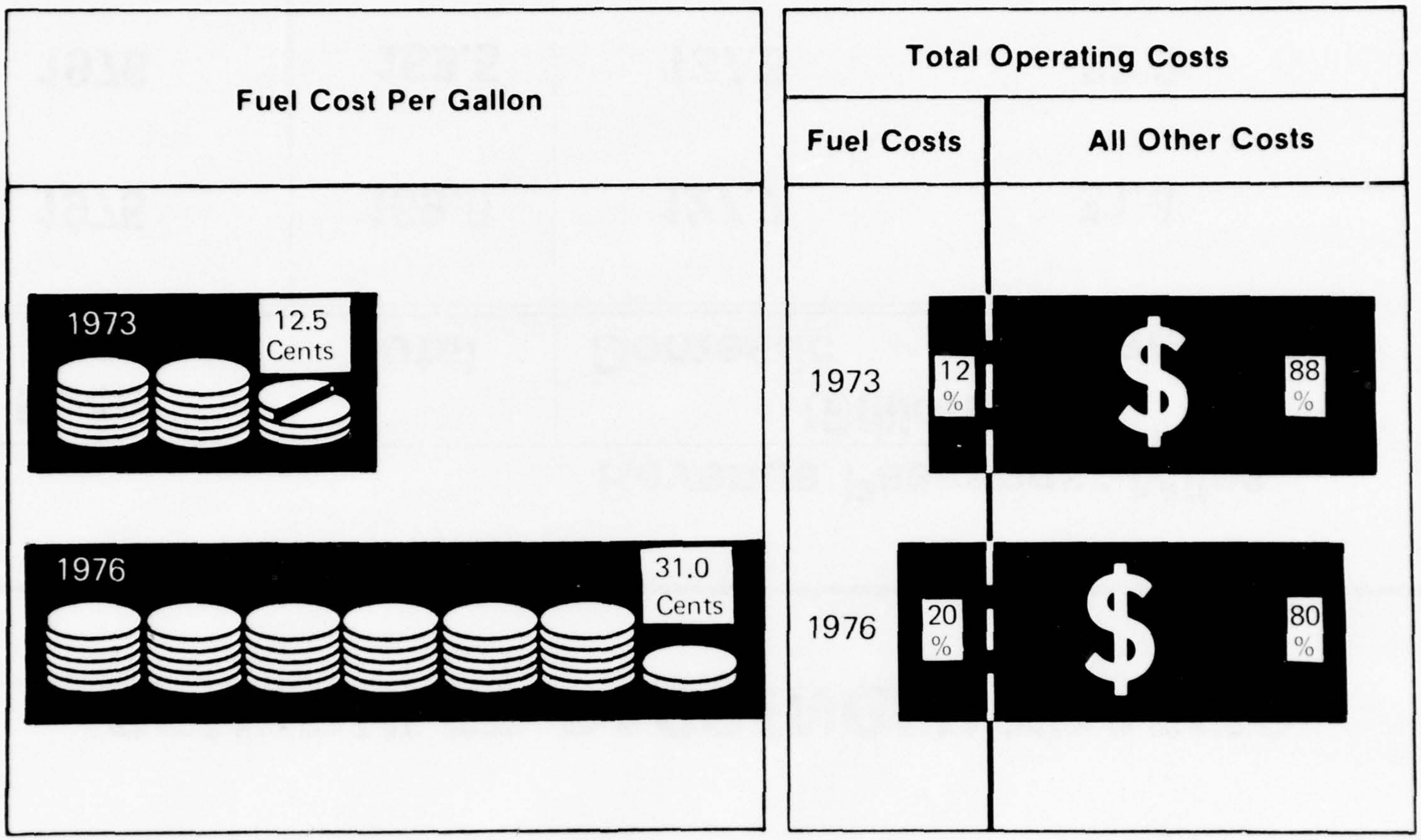


Figure 4

OPERATING PROFIT
(MILLIONS)

Scheduled Air Carrier Industry

Fiscal Year	Total	Domestic	International
1975	$280	$316	$(36)
1976	$333	$303	$30

Figure 5

OPERATING PROFIT

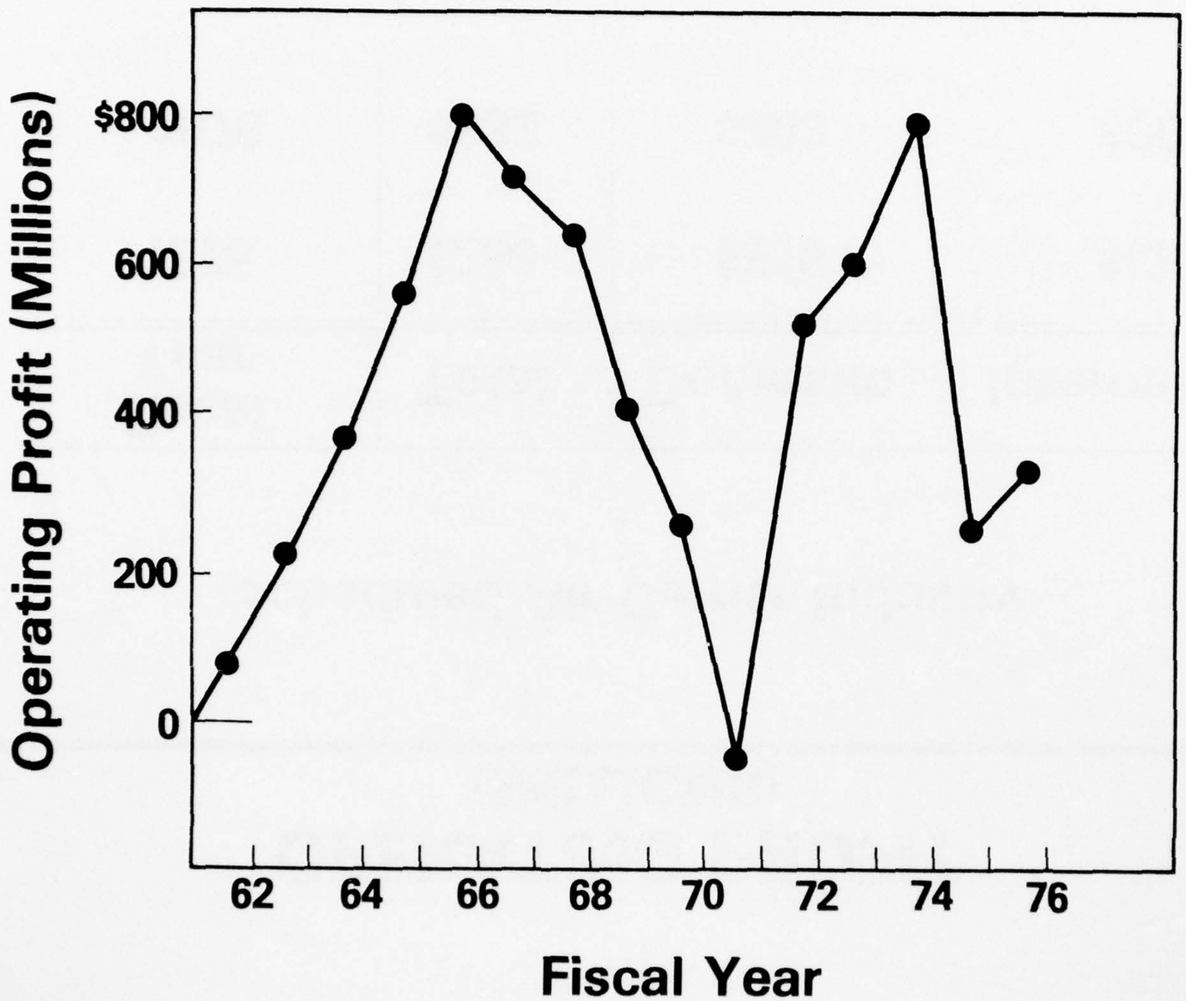


Figure 6

OPERATING PROFIT PER REVENUE DOLLAR

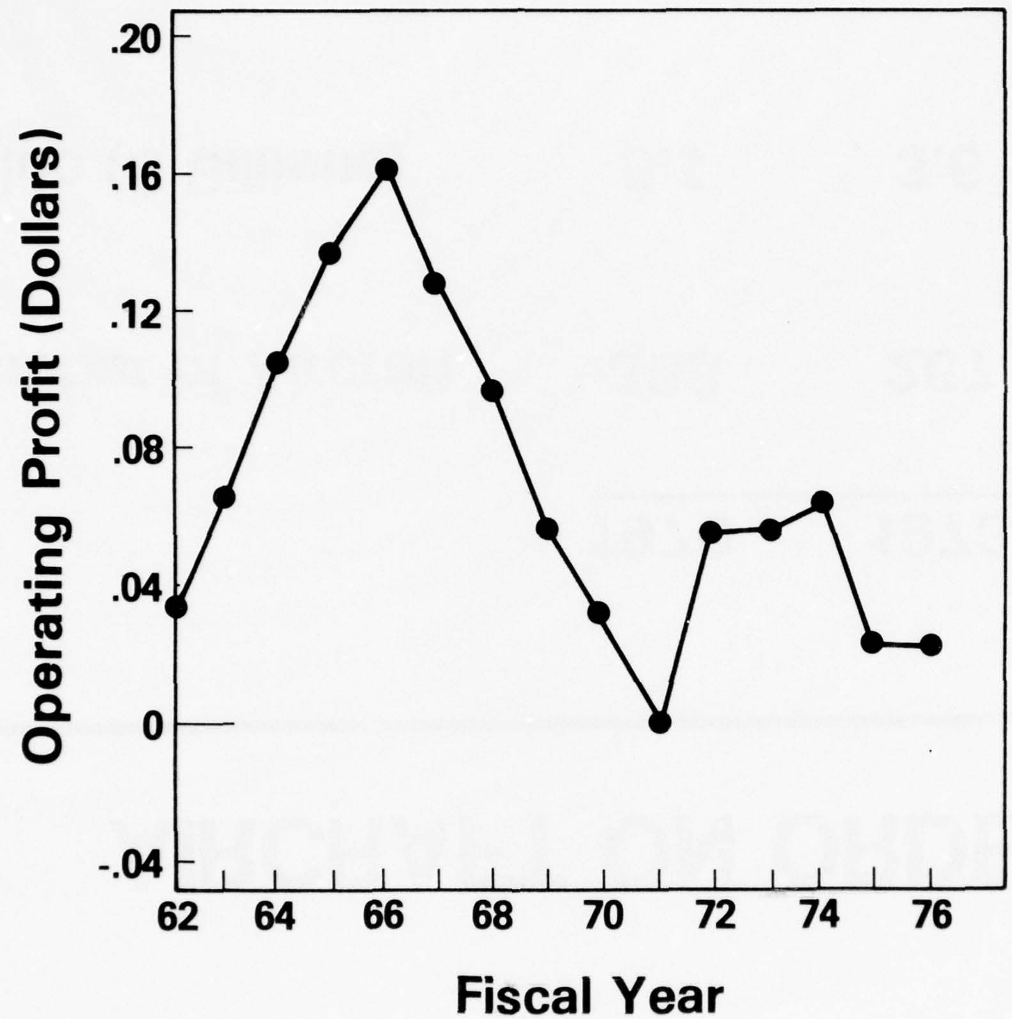


Figure 7

AIRCRAFT ON ORDER

	1970	1973	1976
Number of Aircraft	368	267	123
Value ($ Billions)	5.5	3.6	1.7

Figure 8

SCHEDULED PASSENGER TRAFFIC

Fiscal Year	Passenger Enplanements (Millions)		Revenue Passenger—Miles (Billions)	
	Domestic	International	Domestic	International
1976	195.1	16.7	137.3	32.2
1988	393.2	35.3	288.6	73.2
Average Growth Rate Per Year	6.0	6.5	6.4	7.0

Figure 9

AIR CARRIER FLEET

	1976	1988
Total Aircraft	2,523	3,507
Jet	2,126	3,303
2-Engine	514	1,180
3-Engine	1,003	1,659
4-Engine	619	464
Turbo Prop	261	155
2-Engine	189	130
4-Engine	72	25
Piston	119	30
1&2 Engine	76	30
4 Engine	43	—
Helicopter	7	19

Figure 10

COMPARISON OF ACTIVE AIRCRAFT FLEET TO HOURS FLOWN

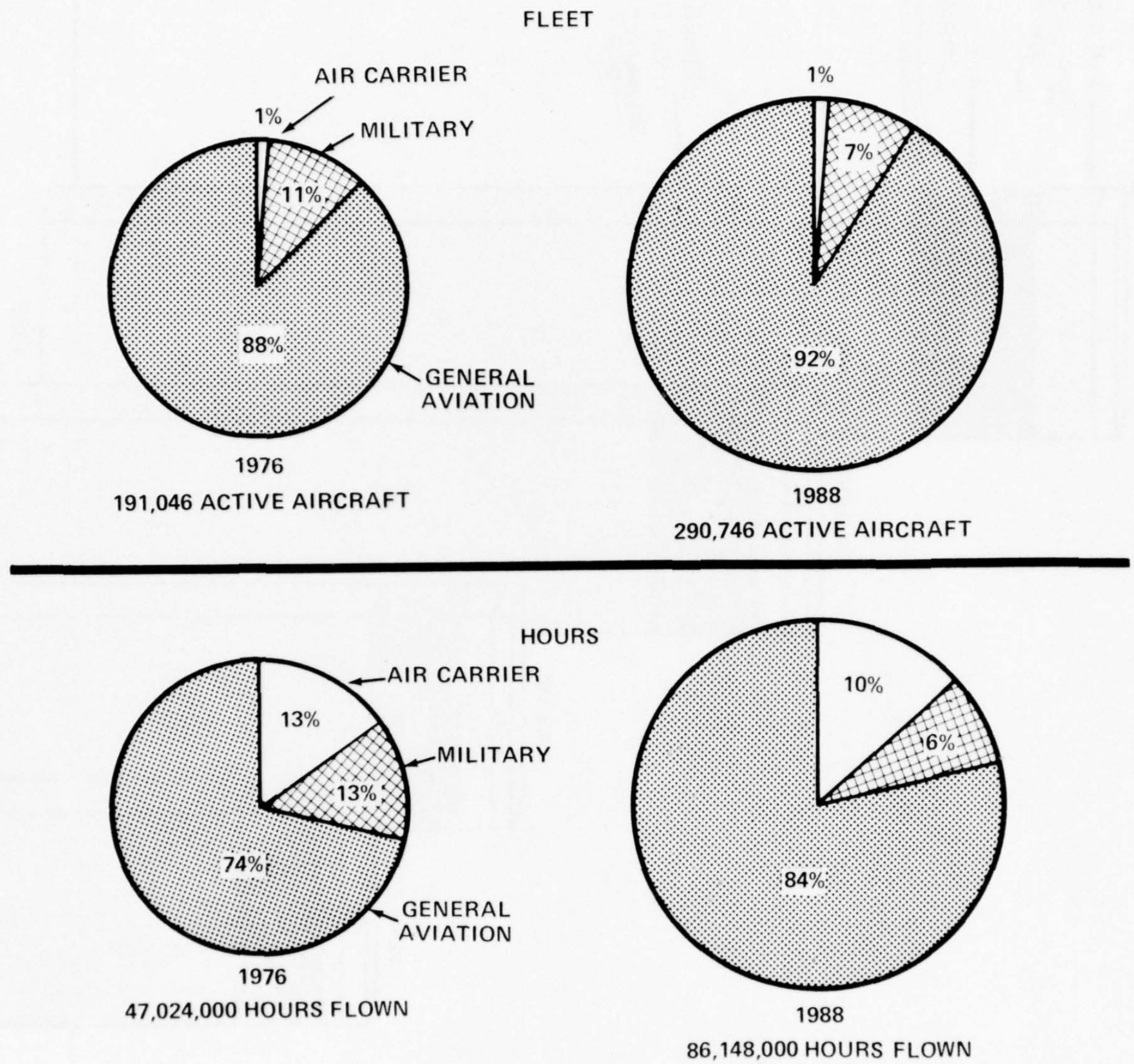
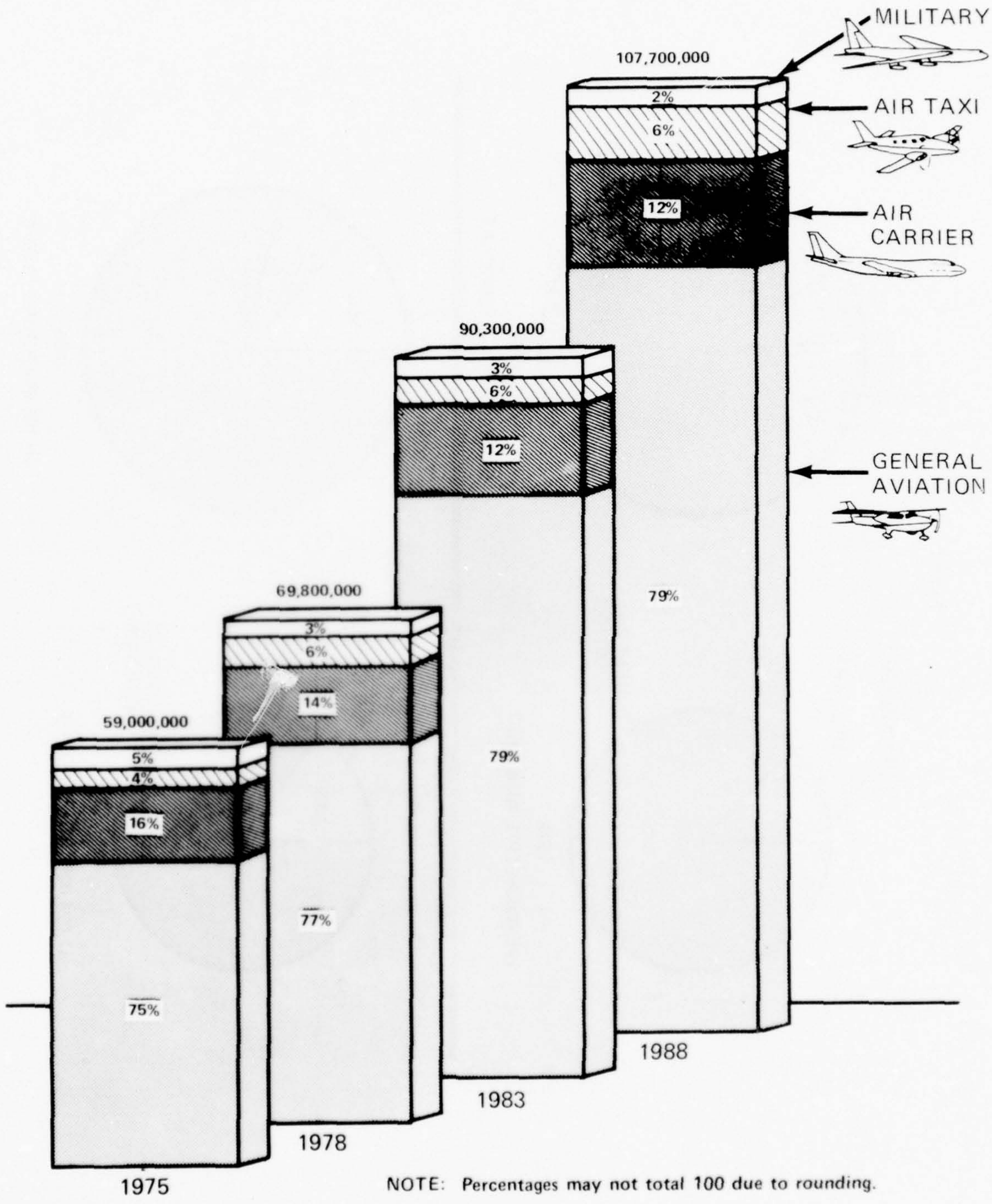


Figure 11

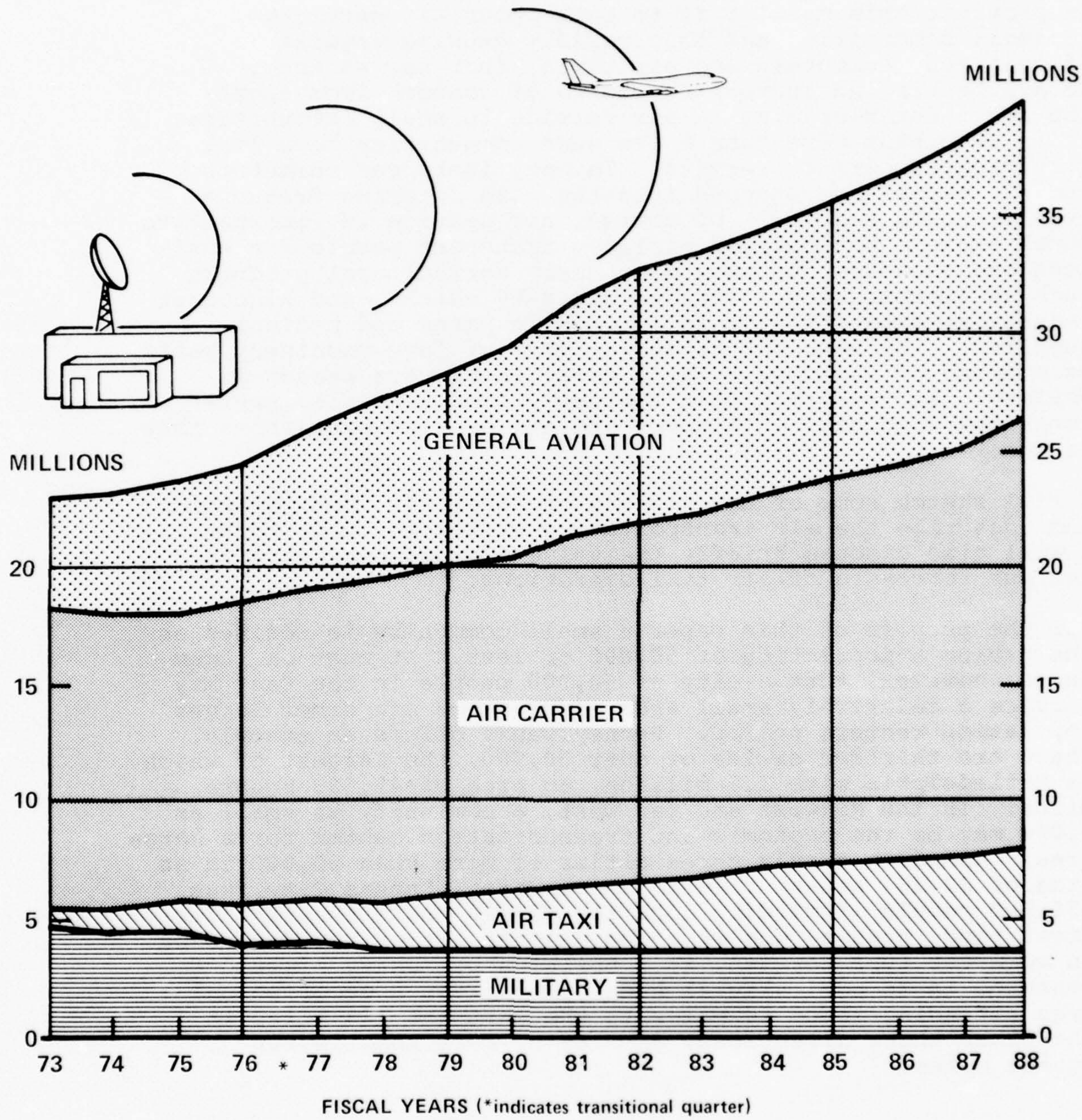
TOTAL AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE



NOTE: Percentages may not total 100 due to rounding.

Figure 12

IFR AIRCRAFT HANDLED BY FAA AIR ROUTE TRAFFIC CONTROL CENTERS



AIR SERVICE TO SMALL COMMUNITIES

- Regina Van Duzee
Industry Economist, FAA

My province this morning is to talk about air services to small communities and that rapidly growing segment of aviation, commuters and air taxis, that serves them. We are hearing an increasing chorus of concern from those who see a deterioration in air service to small communities. It is true that more than a few such communities have lost certificated carrier service. In many instances commuters and air taxis have stepped into the void offering frequent even improved service. Of course, air service is important to rural areas. Not only do airlines transport people for business and pleasure but they also carry agricultural products such as strawberries, flowers, and baby chicks, and high cost industrial products such as automobile parts and medical supplies. The need for rapid delivery of farm machinery parts as a means of avoiding a day's delay in harvest season is obvious. Surveys show that business firms generally prefer locations that have an airport and air service over those that do not.

I will sketch some of the history of rural air transportation and describe the air transportation system as it is today. I will also discuss briefly the value of rural air service, and our forecasts of air taxi operations.

For the purpose of this paper a small community is defined as one having a population of 50,000 or less. It must be remembered, however, that a city of 50,000 people in the East may service a relatively small area since there are other larger population centers nearby. Pennsylvania offers an example. There are thirteen cities of over 50,000, the largest of which is Philadelphia with 1.9 million, an area of 45,333 square miles. In the Midwest and far West, a community as small as 5,000 may be the economic and transportation center for a large area. Kansas has only three cities of more than 50,000 in an area of 82,264 square miles. The largest, Kansas City, has 676,000 people (including both the Kansas and Missouri sides). Great Bend, Kansas, one of those deleted cities now depending on commuter type service, is a thriving community of 20,000 centered in an agricultural area. It serves a geographical area extending about 40 miles to the east and 125 miles in the other three directions, an area of more than 10,000 square miles.

History

In its formative years, the U.S. air transportation system consisted of a group of trunk carriers making transcontinental flights in a series of short hops. The passage of the Aviation Act of 1938 nurtured the infant industry. The Act formed the Civil Aeronautics Board (CAB) charging it with responsibility to regulate air transportation, to foster sound economic conditions in the industry and to coordinate civil air transport. As the original trunk carriers grew and the capabilities of their aircraft improved, they concentrated services in the long-haul routes, limiting and in some cases even reversing expansion to smaller communities. A group of airlines later referred to as local service carriers started operating to the low density short-haul points. The DC-3 dominated the early local service fleet because it was available at low cost after World War II. The average flight between stops was 64 miles, and each of the average 5.6 passengers on board traveled about 200 miles.

The Board encouraged the development of this group of carriers specializing in providing air service to short-haul, low density points. The Board recognized, however, that service at points with limited traffic potential might be economically difficult and was prepared to provide subsidy. It was assumed that as traffic developed, subsidy needs would decrease. However, rapidly developing aircraft technology interfered with this plan. As larger, faster, more efficient jet equipment appeared on the scene, the local service carriers, seeing the cost and service advantages, moved to equip their fleets with the more efficient aircraft. But the DC-9's and B-737's developed for the short-haul market also contained more seats. Those low density points that might provide sufficient load factors to support a Convair or Fairchild 227, would not provide a breakeven load factor on the larger craft despite their efficiency. In addition, once the move to jets was well underway, commonality of fleet became an important factor and the local service carriers proceeded to eliminate the older turboprop aircraft from their fleet. In its efforts to aid the industry in obtaining a reasonable return on investment and to lower subsidies, the CAB granted local service carriers increasingly longer routes so that they have become in essence regional carriers. The pattern of local service carriers replacing trunks now repeats itself. Commuter carriers using small aircraft better tailored to the market are replacing local service carriers in communities that do not generate sufficient traffic to support the large aircraft of the local service carriers.

Rural Air Service Today

The CAB has permitted certificated carriers to abandon service at unprofitable points when adequate replacement service can be provided. At the end of 1970, certificated carriers were serving 435 of 467 authorized points. By the end of 1975, they were serving 382 of 433 authorized points--a decline of almost 12 percent. Some of these dropped points have been permanently removed from the carriers' route certificates while others are under temporary suspension. Of the 647 communities receiving air service in the 48 contiguous states, 218, almost 34 percent, are served exclusively by commuter airlines.

Commuters were first formally recognized by the CAB in 1969 when they were defined as those carriers operating by exemption under Part 298 who either perform at least five regularly scheduled round trips per week between two or more points or transport mail. They are subject to limited regulation and reporting requirements, are allowed free access to all markets, have no route protection and no subsidy. They are permitted to operate aircraft up to 7,500 pound payload carrying a maxium of 30 passengers.

An analysis of CAB data highlights the changes in service to communities under 100,000 population as illustrated by Table 1. In 1970, 44 of those points were served by trunk carriers, 239 by local service carriers and 187 by commuters. In 1975, the numbers were 36 for trunk, 204 for local service and 224 for commuters--a decrease of 18.2 percent for the trunks, 14.6 percent for locals and an increase of 19.8 for commuters.

Table II indicates that the pattern of service is also changing. In 1970, trunks and locals offered a total of 9,075 weekly flights and commuters 6,324. In 1975, the total was 7,676 compared to 7,126 offered by commuters. The percentage decrease for trunks and locals was 2.9 and 17.7, respectively, with commuters showing a 12.9 percent increase.1/ If the upper population limit of this study were set at 50,000, no doubt the change would be even more striking. It is apparent that the trend toward decreased local service by certificated carriers is accelerating.

1/ Department of Transportation, Air Service to Small Communities, March 1976

A number of states and regional commissions have been grappling with the problem of reduced service to their rural areas and have produced studies that bear on the subject. An Iowa State University study 2/ indicates that there has been a consistent decline in the quality of public transportation service in Iowa. The level of bus service and rail passenger service has decreased sharply. Railroad mileage is declining and motor truck service is of uncertain quality. Commercial air service affords extremely limited coverage and air charter service is not widely used. The net result is that residents of smaller communities are limited almost exclusively to automobile travel for personal mobility and are strongly dependent upon private trucking for movements of goods. However, it is difficult to measure how much of the shift to the automobile is due to a decline in available public transport. Some may be attributed to personal preference and the improvement of the highway system.

The study found intrastate air service very limited and inconvenient. From Burlington, Iowa, located in the southwestern corner of the state, it is necessary to make connections in St. Louis or Chicago to reach any other Iowa city. Des Moines is the only city in Iowa having reasonably adequate north-south service. To travel north from Ft. Dodge in Central Iowa to Minneapolis, it is necessary to make connections in Chicago or Omaha. Consequently, it takes considerably less time to drive the 225 miles to Minneapolis than to fly on the circuitous route.

The Ozarks Regional Commission (ORC) 3/ which includes the states of Arkansas, Kansas, Louisiana, Missouri, and Oklahoma also sponsored a study of regional air service. Although 80 cities in that region once had air service, now only 44 are served by certificated carriers. According to the report, recent studies and Government statistics demonstrate that the population migration to urban areas which began after World War II has reversed both nationally and within the Ozark region--the trend perhaps is due in part to a recognition of the attractive quality of life in small communities and the lower

2/ Department of Transportation, Integrated Analysis of Small Cities Intercity Transportation to Facilitate the Achievement of Regional Urban Goals, June 1974

3/ Ozarks Regional Commission, Regional Air Service Demand Study prepared by Beauvais, Roberts and Kurth, September 1976

living costs. The study points out that while the larger cities are typically served by a number of certificated carriers, the smaller community must rely on one carrier. When that carrier is faced with increasing costs and insufficient traffic, it cannot meet expenses. As a result, it applies for permission to suspend service. Without this carrier, no alternative service is available to the small community air traveler.

Value of Rural Air Service

Air service contributes in a number of ways to the economic development of the nation's rural areas. The U.S. Department of Commerce conducted a survey of 3,000 manufacturing firms to determine factors influencing industrial location decisions.4/ The availability of scheduled air service and the preferred community size were two survey items. Table III depicts the results. Over 64 percent of the firms responding indicated that the presence of scheduled air service was of average or greater significance in their location decisions. In over 11 percent of the plant location decisions, availability of air service is considered critical. Surprisingly, cities of under 25,000 were the preferred size for over 20 percent of the firms with about 40 percent choosing cities of 50,000 or less.

Although we think of air service, particularly that offered by commuters, as being used primarily for carriage of passengers, cargo and mail carriage is also important to rural areas. By recent count, the Postal Service has 110 mail contracts with commuter operators worth about $15 million, providing service to 200 cities.

A number of products from rural areas are shipped by air. Harbour Airlines transports fish from Astoria, Oregon, to Portland and thence on to other cities. Sedalia, Marshall, Boone Airline (SMB) carries parts for farm machinery. In fact, the manufacturers of farm machinery have support systems developed for fast delivery of equipment parts. Deere and Company, Moline, Illinois, has a "flash" service promising one day delivery. To achieve this, they frequently must utilize commuters to reach remote points in order to avoid the difference of a day's layup of equipment during the harvest season. Emery Air Freight ships 10-pound grain samples by commuter from rural areas for transshipment to foreign countries.

4/ Industrial Location Determinants, 1971-75. Economic Development Administration, U.S. Department of Commerce, 1973.

The benefits of rural air service are diverse. It offers improved quality of life by affording rural citizens linkage to the national air transportation network, access to recreational areas and special emergency services, such as air ambulance.

Future of Small Community Service

Rural areas must face economic reality when assessing their air service needs. Many communities are extremely reluctant to lose even poor certificated carrier service because of the prestige factor involved and a preference for large aircraft. However, certificated carriers providing service to small communities are faced with inflationary problems common to all plus additional costs unique to small community service. These costs are high unit operating costs of aircraft used to serve these cities, cost pressures created by operating aircraft disproportionate to passenger demand and federal subsidy which fails to cover the cost of service. Low traffic areas must realize that the hope for adequate service lies in an expanded network of commuter carriers.

Commuter passenger traffic has grown at an average annual rate of almost 9.5 percent since 1970 and totaled 6.7 million passengers by the end of 1975. A number of factors lead us to believe that this rapid growth will continue. In the present climate of pressure for regulatory reform, the CAB has shown an increasing tendency to allow local service carriers to abandon unprofitable points in favor of commuters. When this happens, the additional frequencies offered have a stimulative effect on traffic. In addition, there has been substantial population and economic growth in outlying rural and surburban areas and public acceptance of commuter type service has increased.

We have contracted for the development of a national forecast of commuter activity--passengers, operations and aircraft fleet. This project will be completed in March. Data from the forecasts will be available at that time and will be included in future Aviation Forecasts. Meanwhile, estimating from our hub and terminal area forecasts, we anticipate commuters may be carrying over 13 million passengers by 1986.

Since commuters providing replacement service with small aircraft usually offer more frequent flights than certificated carriers, they create a substantial increase in operations. This trend is expected to continue and even accelerate over the next decade. We have forecast air taxi operations, both scheduled and unscheduled, to show a healthy average annual growth of more than 6.5 percent through 1988. That means that the 2.9 million operations counted in 1975 will reach 6.9 million by 1988.

It is apparent that commuter type airlines will play an increasingly important role in providing service to small communities and linking them to the national air network.

TABLE I

SERVICE TO COMMUNITIES UNDER 100,000 POPULATION, POINTS SERVED AND WEEKLY FLIGHTS BY TYPE OF CARRIER

SIZE OF COMMUNITY: 1970 POPULATION	NUMBER POINTS SERVED: 1970			NUMBER POINTS SERVED: 1975		
	TRUNK	LOCAL	COMMUTER	TRUNK	LOCAL	COMMUTER
0-25,000	17	131	113	13	112	144
25,000-50,000	18	80	52	16	66	60
50,000-75,000	3	12	10	2	11	10
75,000-100,000	6	16	12	5	15	10
TOTAL	44	239	187	36	204	224

	PERCENT CHANGE: 1970 TO 1975		
	TRUNK	LOCAL	COMMUTER
0-25,000	-23.5	-14.5	27.4
25,000-50,000	-11.1	-17.5	15.4
50,000-75,000	-33.3	-8.3	0
75,000-100,000	-16.7	-6.2	-16.7
TOTAL	-18.2	-14.6	19.8

SOURCE: DATA FROM CIVIL AERONAUTICS BOARD

TABLE II

SERVICE TO COMMUNITIES UNDER 100,000 POPULATION, POINTS SERVED AND WEEKLY FLIGHTS BY TYPE OF CARRIER

WEEKLY FLIGHTS AT POINTS SERVED IN BOTH 1970 AND 1975

	1970			1975		
	TRUNK	LOCAL	COMMUTER	TRUNK	LOCAL	COMMUTER
0-25,000	279	3,332	3,446	250	2,806	3,722
25,000-50,000	564	2,949	1,838	603	2,359	2,002
50,000-75,000	119	556	544	132	431	689
75,000-100,000	437	839	496	373	722	713
TOTAL	1,399	7,676	6,324	1,358	6,318	7,126

PERCENT CHANGE: 1970 TO 1975

	TRUNK	LOCAL	COMMUTER
0-25,000	-10.4	-15.7	8.0
25,000-50,000	6.9	-20.0	8.9
50,000-75,000	10.9	-22.4	26.6
75,000-100,000	-14.6	-13.9	43.7
TOTAL	-2.9	-17.7	12.9

SOURCE: DATA FROM CIVIL AERONAUTICS BOARD

TABLE III
INDUSTRIAL LOCATION DETERMINANTS
U.S. DEPARTMENT OF COMMERCE SURVEY

IMPORTANCE OF AIR PASSENGER SERVICE IN INDUSTRIAL LOCATION DECISIONS	PERCENT OF FIRMS
OF CRITICAL VALUE	11
OF SIGNIFICANT VALUE	17
OF AVERAGE VALUE	36
OF MINIMAL VALUE	33

PREFERRED COMMUNITY SIZE IN INDUSTRIAL LOCATION DECISION: POPULATION	PERCENT OF FIRMS
UNDER 25,000	20
25,000-49,999	18
50,000-99,999	18
100,000-249,999	17
250,000-499,999	8
500,000-999,999	7
1,000,000 OR MORE	10
NO RESPONSE	3

FORECASTS OF GENERAL AVIATION ACTIVITIES

- Thomas F. Henry
Industry Economist, FAA

Good morning. As in the previous aviation forecast conference, I will discuss some aspects of FAA's forecasts of general aviation activities.

First, let me provide you with a little background information about the general aviation industry.

<u>BACKGROUND INFORMATION</u>--State of the Industry.

In CY 1975, despite the impact of the national recession which affected most industries adversely, the general aviation industry experienced the best dollar sales year in its history. The General Aviation Manufacturer's Association (GAMA), representing companies which produce 99 percent of the Nation's general aviation aircraft and equipment, reported that the industry shipped approximately 14,075 aircraft valued at over one billion dollars. Production continued at a relatively high level during the first ten months of CY 1976. Net billings totaled about $990 million for the first ten months, up 16 percent from the comparable period in 1975. These data are suggestive of another record sales year.

Exports of general aviation aircraft remain a significant source of earnings to the industry. In CY 1975, exports accounted for 30 percent of the total dollar value of U.S. shipments of G.A. aircraft. During the first ten months of CY 1976, 27 percent of total shipment value was exported.

Encouraged by its recent months of successful production and sales, the general aviation industry has undertaken aggressive marketing, educational, and accident prevention programs. These include, for example, the industry's "Take Off" (and sweepstake) program and a documentary film entitled "Making the Difference." The programs are designed to improve safety, to increase the number of G.A. pilots, to increase the public's awareness of the benefits of general aviation flying, and to make travelling by G.A. aircraft more attractive to a larger segment of the travelling public. While such qualitative information has not been factored into our forecast of aviation activities, if the industry's efforts are successful in reaching the desired objectives, production and sale of general aviation aircraft will be stimulated.

We may then confidently expect G.A. flying to increase considerably and to put increased demands on the National Aviation System, perhaps over and above our current forecasts. It is within this context that I present the FAA forecasts of general aviation activities for the 1977-1988 period.

FLEET SIZE

As of January 1, 1976, there were 168,500 aircraft in the general aviation fleet (see Chart 1). The fleet is expected to increase to 226,000 in 1982 and to reach 267,000 by 1988. These data represent a 58 percent increase (3.8 percent annually) during the 1976-1988 period.

By comparison, the average annual rate of growth during the 1960-1976 period was 5.7 percent. During that period, the general aviation fleet more than doubled, increasing from the 1960 total of 68,700 to the 168,500 recorded in 1976.

FLEET COMPOSITION

Single-engine piston aircraft constitute the largest proportion of the general aviation aircraft fleet. As of January 1, 1976, single-engine piston aircraft totaled 137,500, approximately 82 percent of the general aviation fleet (see Table 1). By 1982, the number of single-engine piston aircraft is expected to increase to 180,200, representing 80 percent of the fleet. Multi-engine piston aircraft total 20,300 and are expected to increase to 29,500 by 1982. Turbine aircraft are forecast to increase from 4,300 to 7,700.

AIRCRAFT DISTRIBUTION BY REGION

The distribution of the current fleet of general aviation aircraft by FAA Regions is shown in Chart 2. Currently, the Great Lakes Region accounts for the highest proportion of general aviation aircraft (18 percent). This is followed by the Western, Southern, and Southwest Regions--each with approximately 14 to 15 percent of the total number of G.A. aircraft. By 1982, the proportion of aircraft in the Southern region is expected to increase to about 19 percent. The proportion in the Great Lakes Region is expected to decline to 16 percent. The other Regions are expected to have relatively small changes in their proportions of the total number of G.A. aircraft (about 1 percent or less).

HOURS FLOWN

The number of hours flown in FY 1976 was 35.0 million (see Chart 1). The number of hours flown is expected to increase to 53.9 million in 1982 and to 72.0 million by 1988. The total number of hours expected to be flown in 1988 represents more than twice the 1976 total. This is an average annual growth of 6.2 percent.

During the 1965-1976 period, the average annual increase was 6.5 percent. During that period, the number of hours flown by general aviation aircraft more than doubled--increasing from 16.7 million hours in 1965 to the 35.0 million estimated for 1976.

HOURS FLOWN BY CATEGORY OF AIRCRAFT

Single-engine piston aircraft accounted for 25.0 million hours of operation in 1976 (see Table 2). This is expected to increase by 13.1 million hours to a total of 38.1 million in 1982. The greatest percentage increase (75 percent) is forecast for the turbine category, which will increase their hours of operation from 2.4 million to 4.2 million. As indicated in Table 2, single-engine piston aircraft will account for about 69 percent of the total increase in the number of hours flown.

COMPARISON OF GENERAL AVIATION FLEET SIZE AND HOURS FLOWN

Chart Number 3 shows the composition of the general aviation fleet and the relative share of the total number of hours flown attributable to different types of aircraft. For example, single-engine piston aircraft currently comprise 82 percent of the general aviation fleet; but this type of aircraft accounts for only 71 percent of the number of hours flown. In contrast, multi-engine piston aircraft constitute about 12.0 percent of the fleet, but this aircraft type accounts for 16.3 percent of the hours flown. Similarly, turbine powered aircraft make up only 2.6 percent of the GA fleet but account for nearly 7 percent of the number of hours flown. As indicated in the chart, the number of multi-engine piston and the number of turbine aircraft are expected to increase slightly and are expected to account for a slightly higher proportion of the number of hours flown in 1982 than in 1976. These small increases will come at the expense of the single-engine piston aircraft.

UTILIZATION RATE OF GENERAL AVIATION AIRCRAFT

The data indicated in previous charts suggest that the utilization rate varies for different types of aircraft. This is substantiated by the data presented in chart number 4. For example, turbine-powered aircraft indicate a much higher utilization rate than single-engine piston powered aircraft. Turbojets flew an average of approximately 610 hours in 1976; turboprops flew approximately 520 hours. In contrast, single-engine piston aircraft which comprise about 82 percent of the fleet flew only 180 hours per aircraft on the average. Rotorcraft continue to maintain a relatively high utilization rate. In 1976, helicopters flew an average of approximately 370 hours. As shown in Chart 4, the utilization rate of the fleet, as a whole, is expected to increase during the forecast period. Most of the increase is expected to occur in the single-engine and multi-engine piston aircraft categories. These are, currently, the less heavily utilized categories.

GENERAL AVIATION FLEET BY USER CATEGORY

Chart number 5 shows the fleet composition by selected user categories. We may note the high proportion of turbine and multi-engine piston aircraft that are utilized for business purposes--79 percent, in the case of turbine aircraft and 61 percent, in the case of multi-engine piston aircraft. In contrast, only 21 percent of single-engine piston aircraft are used for business purposes. These proportions are based on CY 1974 data; but they are virtually unchanged from those computed for CY 1973.

FUEL CONSUMED

In FY 1976, general aviation aircraft consumed a total of 499 million gallons of aviation gasoline (see Chart 6). This constituted approximately 96 percent of all aviation gasoline consumed. By 1982, consumption of gasoline by general aviation aircraft is expected to increase to 772 million gallons (99 percent of all aviation gasoline). The 1982 level represents an increase of 55 percent over the amount of aviation gasoline consumed in 1976.

In 1976, general aviation aircraft used a total of 572 million gallons of jet fuel (approximately 7 percent of the total consumption of jet fuel). By 1982, the consumption of jet fuel by G.A. aircraft is expected to increase to 982 million--about 9 percent of all jet fuel.

The data presented previously on the general aviation fleet size and hours flown included air taxis. However, data which will be presented on aircraft operations exclude air taxis. Some of the data on air taxis and air commuters have already been discussed by a previous speaker.

LOCAL AND ITINERANT GENERAL AVIATION AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE

In FY 1976 local and itinerant G.A. aircraft operations at airports with FAA traffic control service totaled 47.6 million. Such operations are forecast to increase by 60 percent to 76.2 million in 1982 and by 79 percent to 85.2 million in 1988. As indicated in chart number 7, itinerant G.A. operations constitute approximately 55 percent of total GA operations. The proportion is expected to increase to 56 percent in 1982 and to decline to 54 percent in 1988. Chart number 7 also shows that currently G.A. aircraft operations constitute approximately 76 percent of total operations at airports with FAA traffic control service. This proportion is expected to increase to 78 percent in 1982 and to 79 percent in 1988.

TOTAL AND GENERAL AVIATION INSTRUMENT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE

The number of general aviation instrument operations totaled 12.8 million in 1976 (see Chart 8). This constituted 46 percent of all instrument operations. The number of G.A. instrument operations is forecast to increase by 76 percent to 22.5 million by 1982 and by 125 percent to 28.8 million by 1988.

As indicated in chart number 8, G.A. instrument operations is expected to form an increasing proportion of total instrument operations: 56 percent in 1982 and 58 percent in 1988.

TOTAL AND GENERAL AVIATION IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS

In FY 1976, G.A. instrument flight rule (IFR) aircraft handled at FAA Air Route Traffic Control Centers totaled 6.0 million (see Chart 9). IFR aircraft handled is expected to increase by 77 percent to 10.6 million in 1982 and by 123 percent to 13.4 million in FY 1988.

ACTIVE PILOTS BY TYPE OF CERTIFICATE

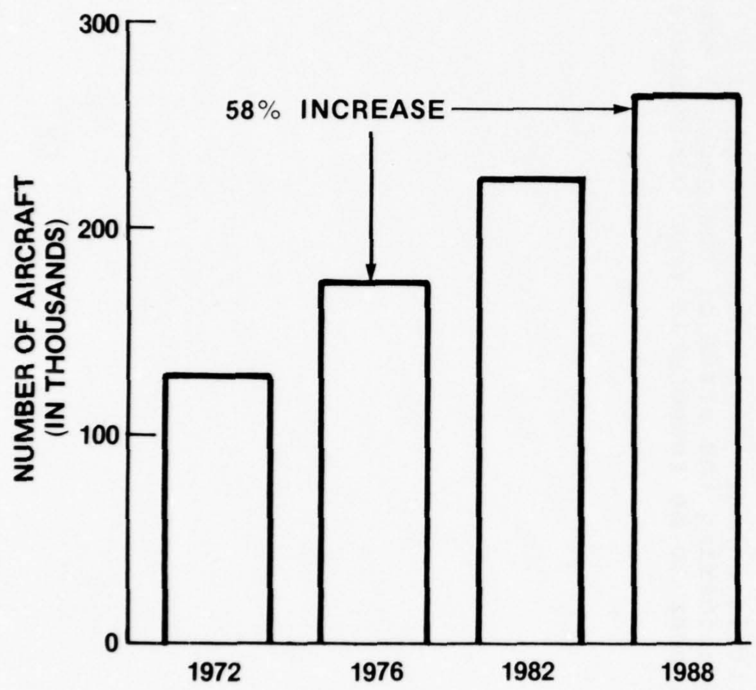
In FY 1976, there were approximately 725,000 active pilots. Of these, 42 percent held private certificates, 26 percent held commercial certificates, and 24 percent were classified as students. The number of pilots is expected to increase to 928,600 by 1982. Chart number 10 shows the total number of pilots and the relative proportions in the different categories for selected years.

The preceding data give us a good indication of the importance of general aviation in the national aviation system. In conclusion, I would like to bring some of these points into sharper focus by looking at some comparative rates of growth of selected general aviation categories (see Table 3). We will make only one final comment about these data. The forecasts of G.A. activities appear to be a little conservative when compared with recent history, but considering the state of the general economy, these forecasts appear to be reasonable from our vantage point.

CHART 1

U.S. ACTIVE GENERAL AVIATION FLEET

(SELECTED YEARS: 1972-1988)



ESTIMATED HOURS FLOWN IN GENERAL AVIATION

(SELECTED YEARS: 1972-1988)

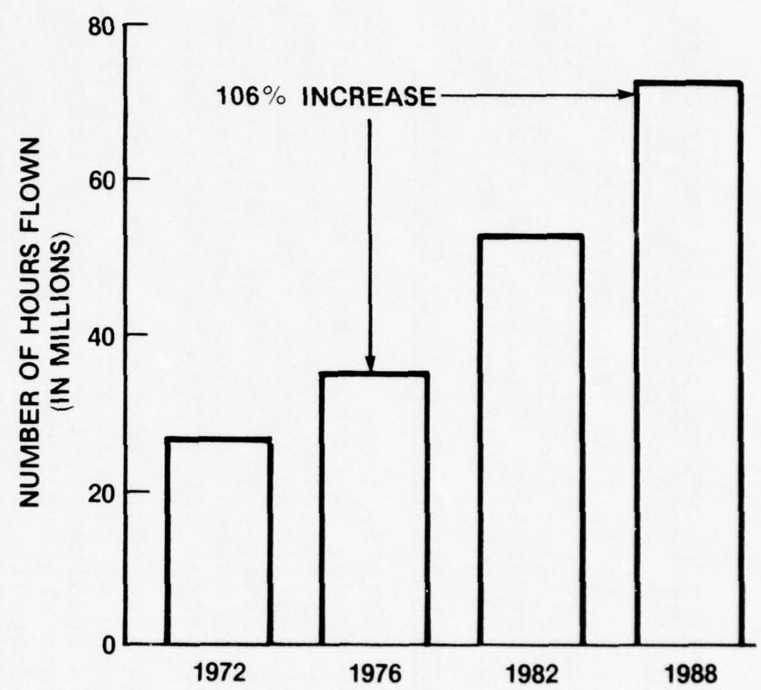


CHART 2

DISTRIBUTION OF GENERAL AVIATION AIRCRAFT BY FAA REGION

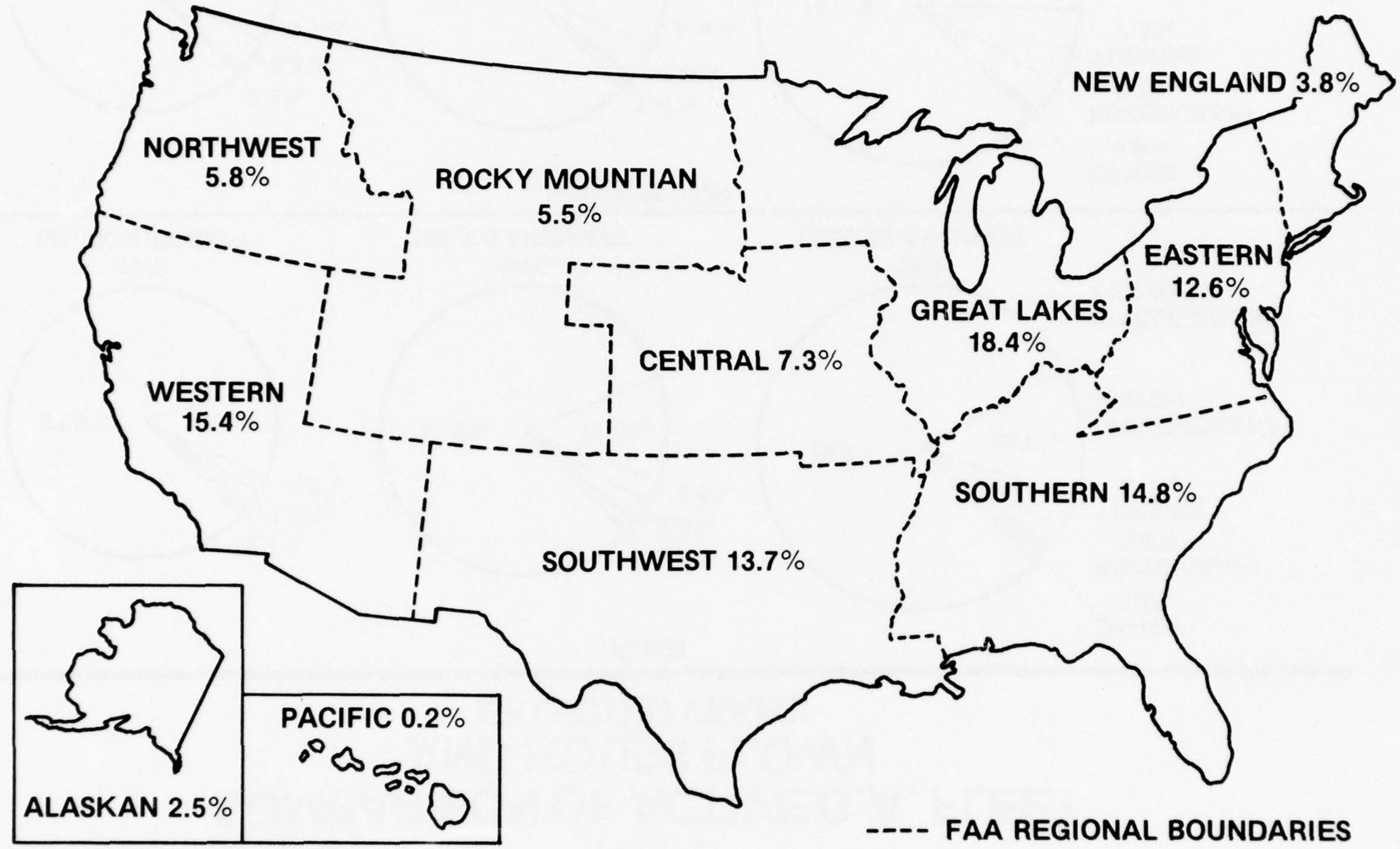
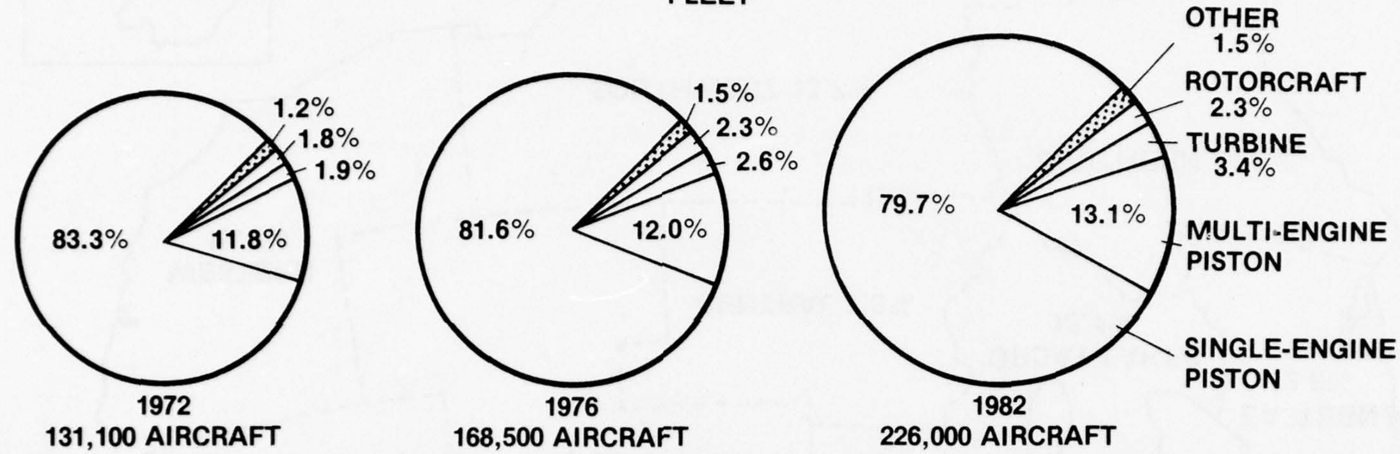


CHART 3

COMPARISON OF ACTIVE G.A. FLEET AND HOURS FLOWN
(SELECTED YEARS)

FLEET



HOURS FLOWN

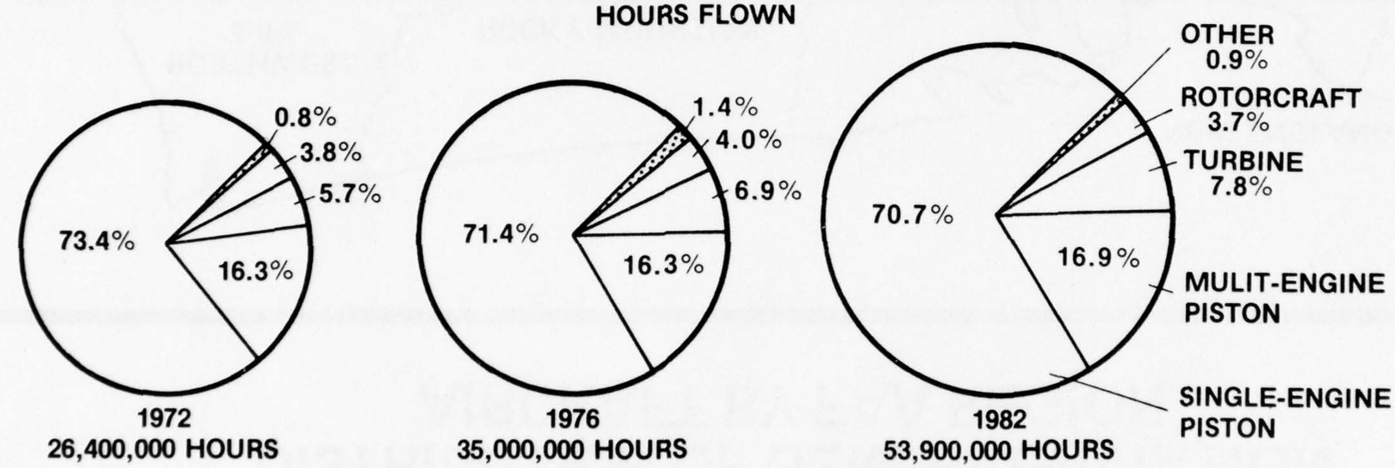


CHART 4

UTILIZATION RATE OF GENERAL AVIATION AIRCRAFT 1972-1982

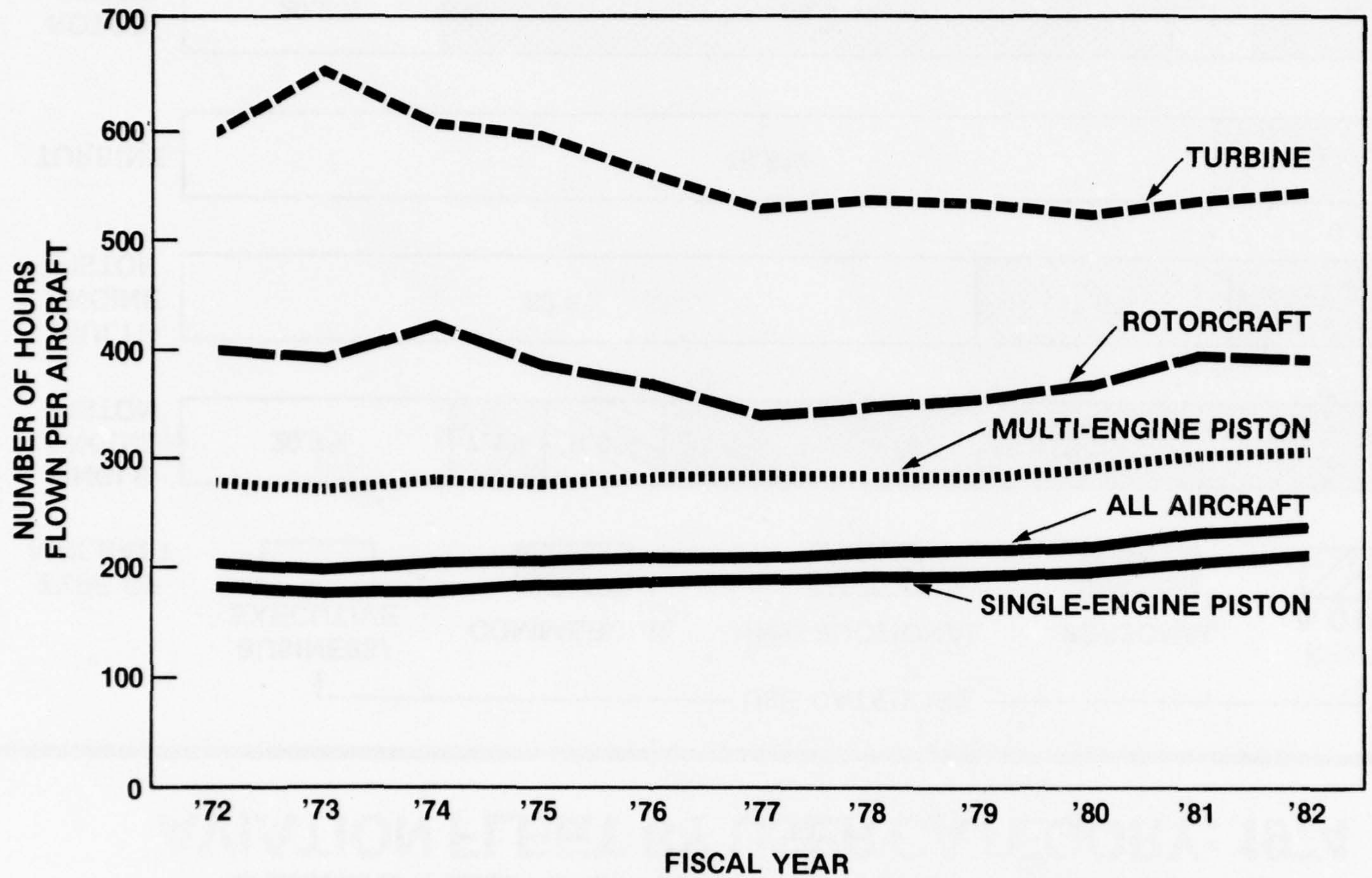
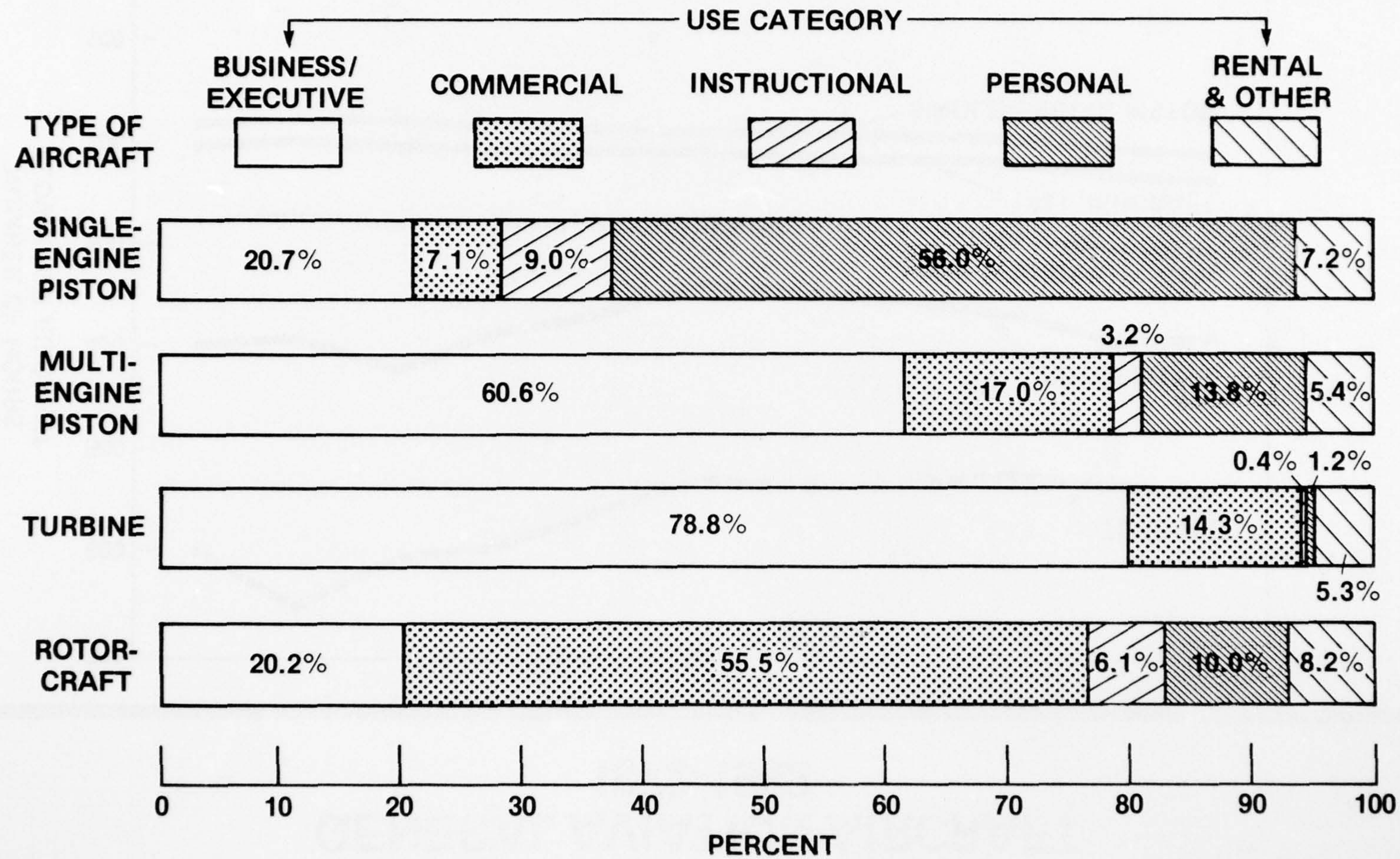


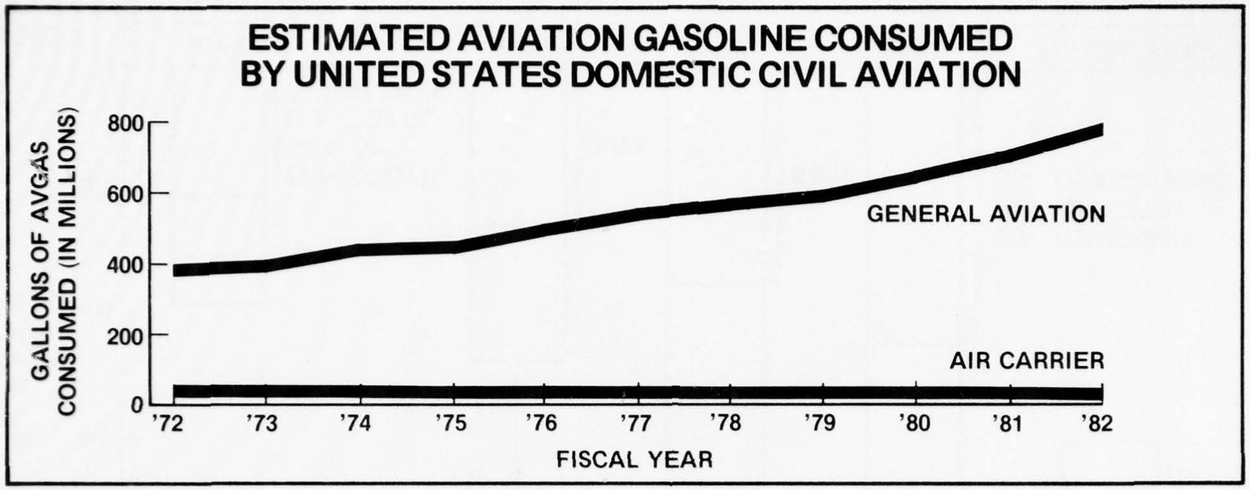
CHART 5

SELECTED COMPONENT OF GENERAL AVIATION FLEET BY USER CATEGORY: 1974

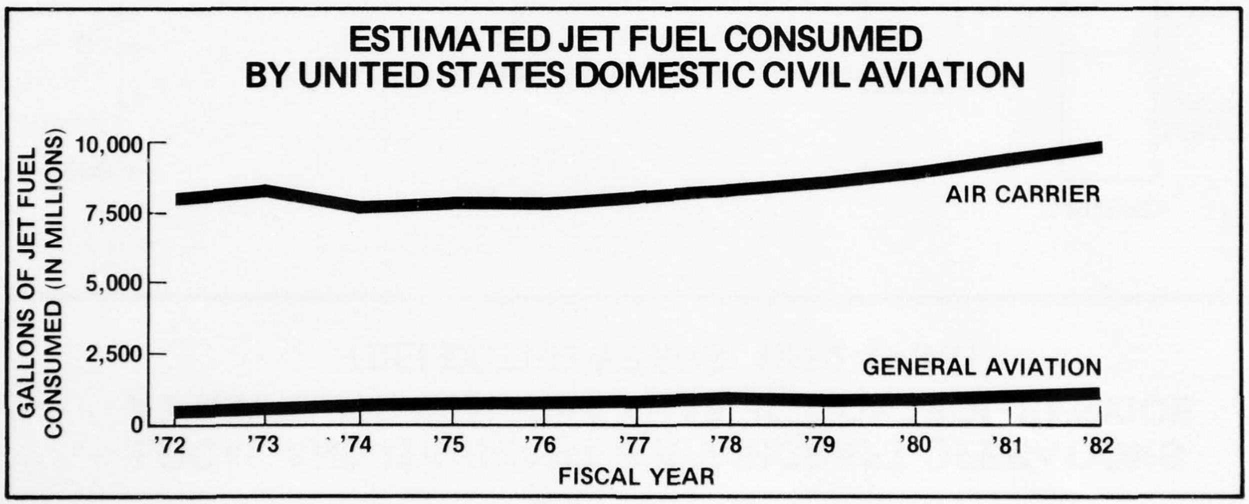


SOURCE: FAA STATISTICAL HANDBOOK OF AVIATION, CALENDAR YEAR, 1974.

CHART 6



ESTIMATED AVIATION GASOLINE CONSUMED BY UNITED STATES DOMESTIC CIVIL AVIATION
GALLONS OF AVGAS CONSUMED (IN MILLIONS)
800
600
400
200
0
GENERAL AVIATION
AIR CARRIER
'72
'73
'74
'75
'76
'77
'78
'79
'80
'81
'82
FISCAL YEAR



ESTIMATED JET FUEL CONSUMED BY UNITED STATES DOMESTIC CIVIL AVIATION
GALLONS OF JET FUEL CONSUMED (IN MILLIONS)
10,000
7,500
5,000
2,500
0
AIR CARRIER
GENERAL AVIATION
'72
'73
'74
'75
'76
'77
'78
'79
'80
'81
'82
FISCAL YEAR

CHART 7

LOCAL AND ITINERANT G.A. AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE (SELECTED YEARS: 1972-1988)

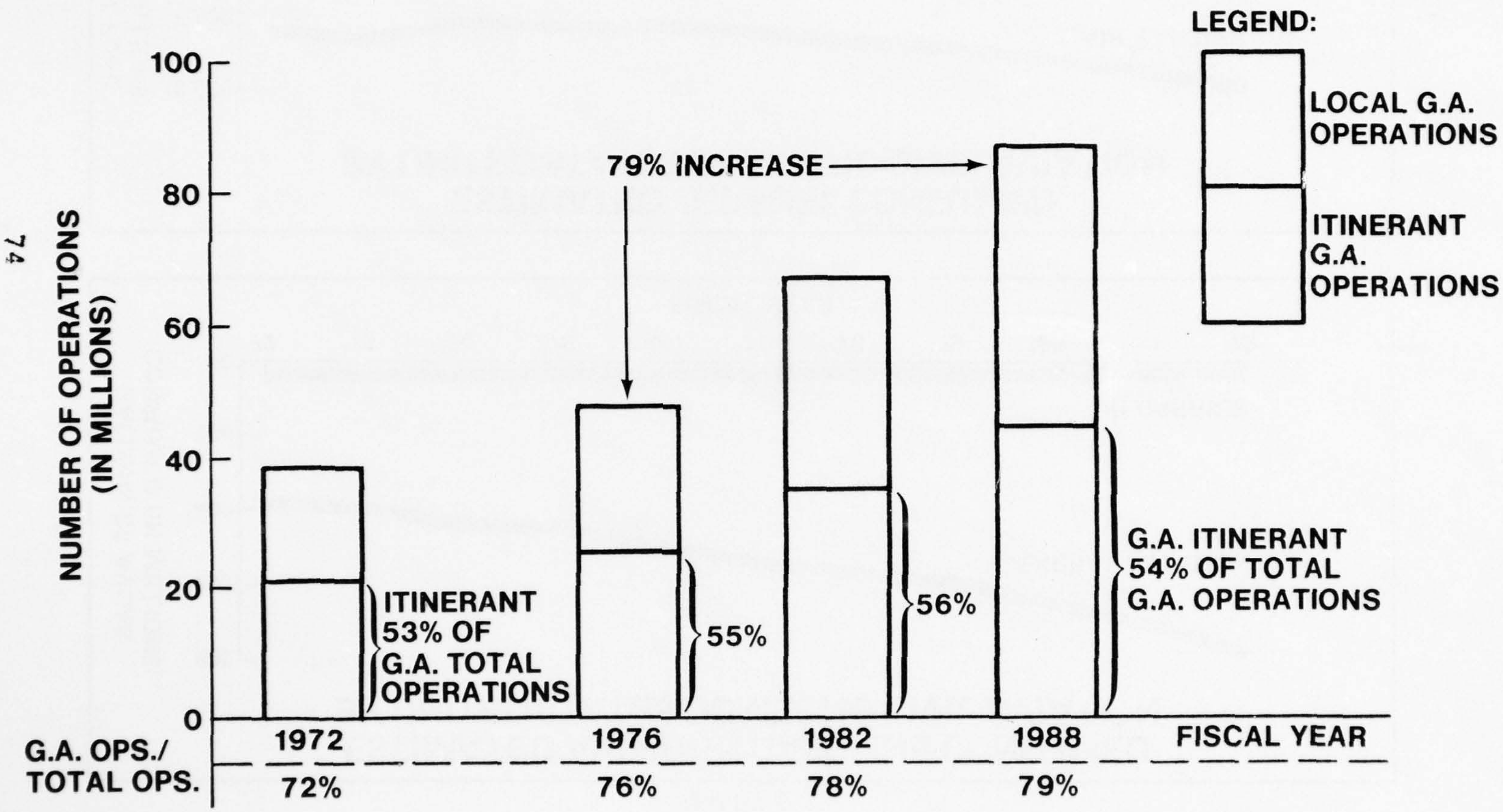


CHART 8

U.S. TOTAL AND GENERAL AVIATION INSTRUMENT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE

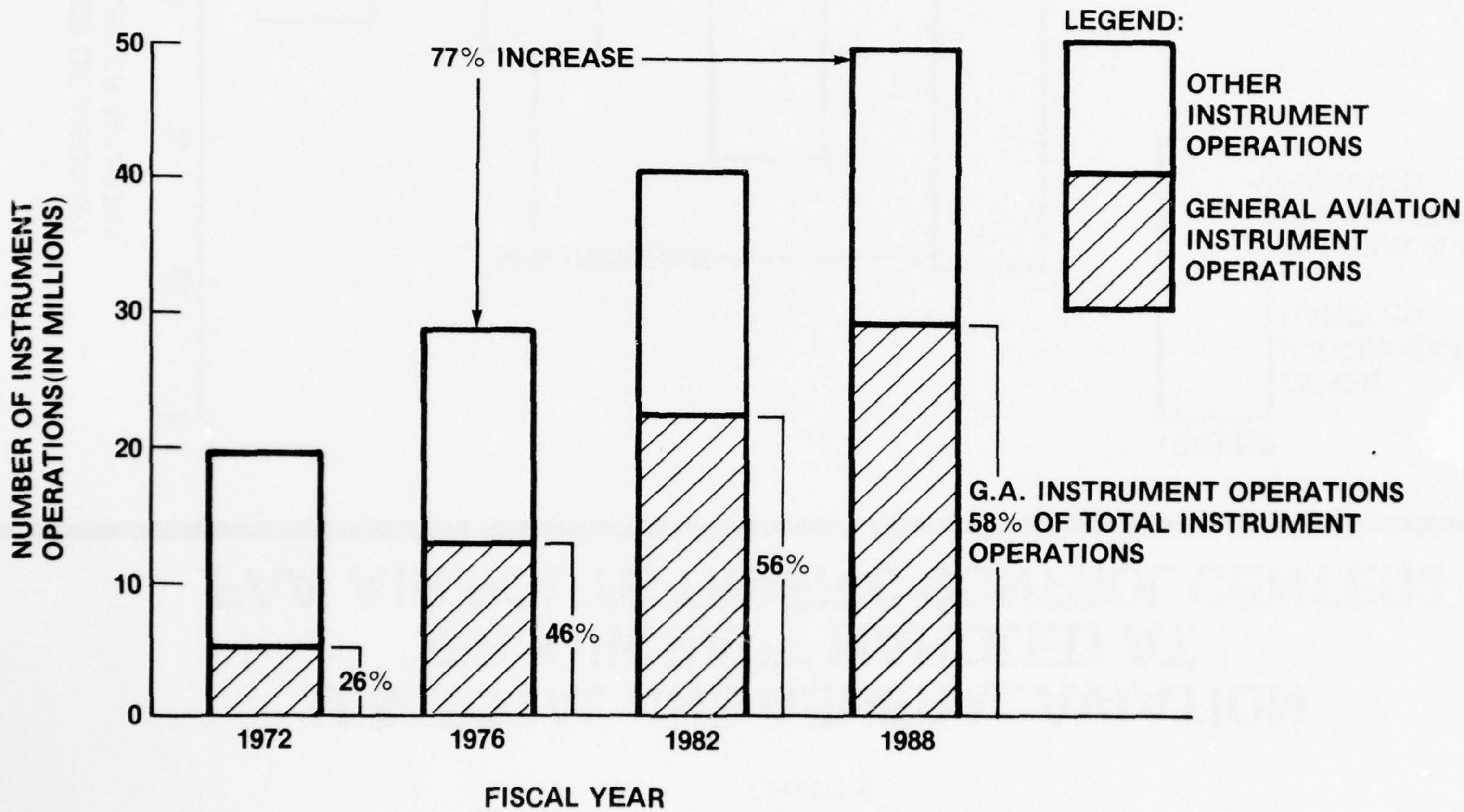


CHART 9

U.S. TOTAL AND GENERAL AVIATION IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS

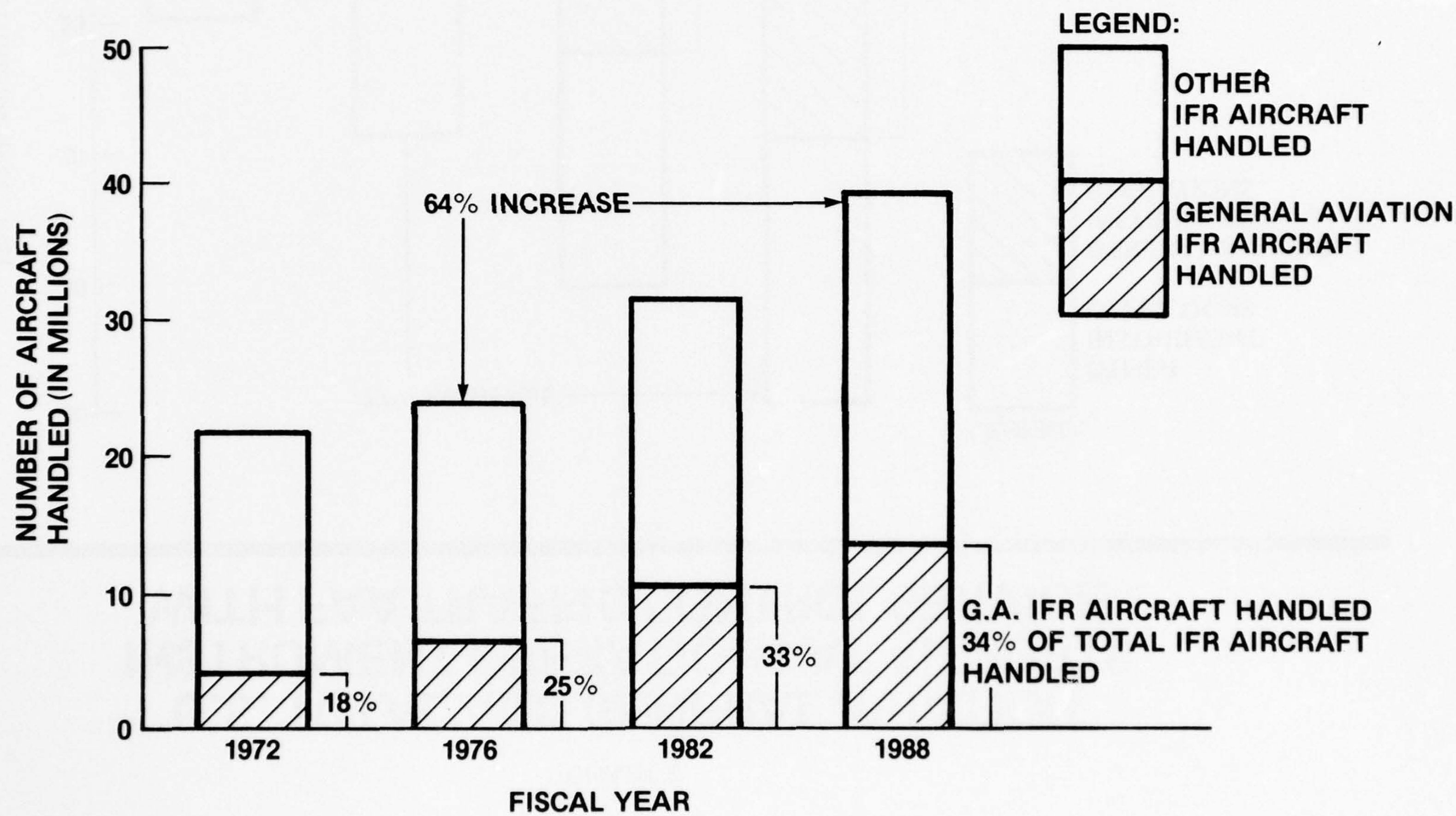


CHART 10

ACTIVE PILOTS BY TYPE OF CERTIFICATE
(SELECTED YEARS)

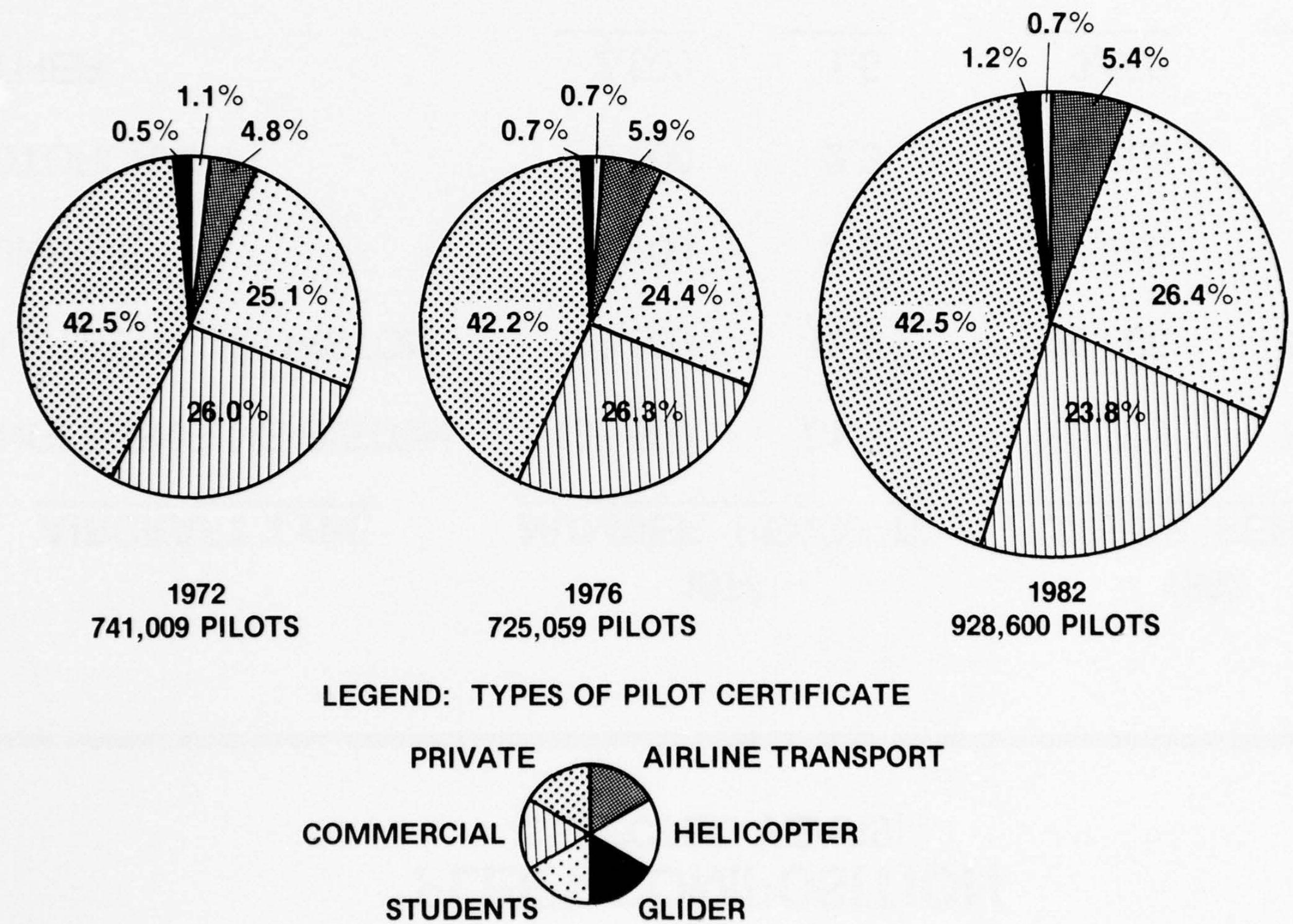


TABLE 1

FLEET COMPOSITION

(SELECTED YEARS)

AIRCRAFT TYPE	1976 NUMBER	1976 PERCENT	1982 NUMBER	1982 PERCENT
SINGLE-ENGINE PISTON	137,500	81.6	180,200	79.7
MULTI-ENGINE PISTON	20,300	12.0	29,500	13.1
TURBINE	4,300	2.6	7,700	3.4
ROTORCRAFT	3,800	2.3	5,100	2.3
OTHER	2,500	1.5	3,500	1.5
TOTAL	168,500	100.0	226,000	100.0

TABLE 2

INCREASE IN HOURS FLOWN BY CATEGORY OF AIRCRAFT

CATEGORY OF AIRCRAFT	HOURS FLOWN (MILLIONS)		INCREASE		PERCENT OF TOTAL INCREASE
	1976	1982	NO.	%	
SINGLE-ENGINE PISTON	25.0	38.1	13.1	52.4	69.3
MULTI-ENGINE PISTON	5.7	9.1	3.4	59.6	18.0
TURBINE	2.4	4.2	1.8	75.0	9.5
ROTORCRAFT	1.4	2.0	0.6	42.9	3.2
OTHER	0.5	0.5	0.0	0.0	--
TOTAL	35.0	53.9	18.9	54.0	100.0

TABLE 3

COMPARATIVE RATES OF GROWTH SELECTED GENERAL AVIATION ACTIVITIES

	1972-1976	1976-1982	1982-1986
FLEET SIZE	6.5%	5.0%	2.9%
HOURS FLOWN	7.4	7.5	5.0
AVGAS	6.2	6.0	5.0
JET FUEL	20.2	9.5	6.7
OPERATIONS			
ITINERANT	6.4	6.4	3.4
LOCAL	4.2	5.7	4.6
INSTRUMENT	26.5	9.7	4.2
IFR AIRCRAFT HANDLED	11.2	10.0	3.9

MILITARY FORECASTS

- Hugh May
  Industry Economist, FAA

Military Aviation Forecasts occupy a significant position in FAA forecasting efforts. Expressed in terms of FAA air traffic workload, the military portion in Fiscal Year 1976 accounted for:

- 4 percent of total aircraft operations at airports with FAA air traffic control towers.
- 13 percent of the total instrument operations at those same FAA-towered airports.
- 17 percent of the IFR aircraft handled workload at FAA air route traffic control centers.
- 6 percent of the aircraft contacted by the FAA at flight service stations and combined station/towers.

The basic military activity series--the projected active aircraft fleet and their volume of flying hours--is furnished us by the Department of Defense and the U.S. Coast Guard. This information is separated in terms of flying services (Air Force, Army, Navy, Marines, and Coast Guard) and also in terms of type of flight equipment (fixed-wing piston, turboprop or jet aircraft and helicopters). The aircraft and hours forecasts are translated into anticipated demands on the National Aviation System (NAS).

This information is incorporated in summary form in the annual edition of the Office of Aviation Policy publication entitled "Aviation Forecasts Fiscal Years 1977-1988." A more detailed presentation of the military information appears in the publication "Military Aviation Forecasts Fiscal Years 1977-1988."

U.S. military active aircraft in the continental 48 States (CONUS) remained constant during the last five years at about 20,000 aircraft. Aircraft flying hours in the same period dropped sharply from 8.1 million to 6.5 million hours, a decrease of 20 percent.

Detailed planning information supplied by the Department of Defense goes through Fiscal Year 1983. The Fiscal Year 1983 forecast shows 20,150 military active aircraft, virtually no change from the current Fiscal Year 1976 total of 20,023 active aircraft. Flying hours for 1983 are projected at 5.7 million, 12 percent less than fiscal 1976 total.

Translating these basic elements (aircraft and hours) into expected FAA air traffic workload, we find FAA towers in Fiscal Year 1983 will probably handle 2.4 million military aircraft operations. FAA flight service stations are forecast to handle 632,000 military aircraft contacts in Fiscal Year 1983.

Military aircraft handled under IFR rules by FAA air route traffic control centers are estimated at 3.9 million in 1983--6 percent below 1976. Military instrument operations are projected to decline slightly (8%) by 1983 to 3.5 million--300,000 less operations than in 1976.

FORECASTS 1977-1988

(1) ACTIVE AIRCRAFT

The United States military services active aircraft inventory will show little change in the 12 years of the forecast period 1977 through 1988. The active military aircraft count will remain at about 20,000 aircraft for the entire period. Composition of the active inventory will show little change except for a further decline in piston fixed-wing planes from 7 percent of the total in 1977 to 5 percent by 1982. Jet fixed-wing aircraft with 49 percent of the total and helicopters with 39 percent account for the bulk of the active military inventory throughout this 12-year span.

The type of aircraft in the inventory, whether turboprop or jet, is not as significant a factor in projecting workload on the National Aviation System (NAS) as the volume of flying hours, so now let us look at aircraft hours.

(2) AIRCRAFT FLYING HOURS

Flying hours logged by the U.S. Armed Forces in the Continental United States have steadily declined since 1972. The Fiscal Year 1976 total of 6.5 million hours was 20 percent less than the 1972 total of 8.1 million hours.

For the next 12 years--1977 through 1988--military aircraft flying hours are expected to fluctuate narrowly between 5.7 million and 5.8 million hours.

(3) AIRCRAFT OPERATIONS

Military aircraft operations at FAA-operated control towers in Fiscal Year 1976 totaled 2.7 million, unchanged from 1975. The FAA forecast projects 2.4 million military aircraft operations for 1977 through 1988.

Past studies have found that FAA towers handle about 10 percent of total military operations--the other 90 percent are handled at military airport bases. Using this assumption, there were 27 million military operations in 1976 and 24 million are estimated for 1977 through 1988.

The 15 busiest FAA-operated traffic control towers in terms of military aircraft operations handled in fiscal year 1976 are shown in Chart 1.

(4) AIRCRAFT CONTACTED

FAA flight service stations and combined station/towers recorded 604,000 military aircraft contacts during Fiscal Year 1976, a drop of 22 percent from the previous year. The FAA forecasts 647,000 military aircraft contacts for Fiscal Year 1977 and volume fluctuating between 636,000 and 632,000 throughout the remainder of the forecast period ending in 1988.

(5) INSTRUMENT FLIGHT RULES (IFR) AIRCRAFT HANDLED

There were 4,170,000 military aircraft handled under IFR conditions at the 27 FAA centers during Fiscal Year 1976, 20,000 less than in Fiscal Year 1975. Planning data supplied by the U.S. military flying Armed Forces on active aircraft and flying hours indicate that approximately 3,900,000 military aircraft will be handled annually during the forecast period 1977-1988.

(6) INSTRUMENT OPERATIONS

Military instrument operations at FAA towers totaled 3.7 million in Fiscal year 1976. The current FAA forecast anticipates a 3.5 million figure for the period 1977-1988.

(7) FAA RELATIONSHIP WITH MILITARY

FAA has had long and very close day-to-day operating relations with the military services as evidenced in the FAA Air Traffic Service where a special Military Activities Branch is devoted to day-to-day liaison work. This branch has 7 liaison units throughout the Continental United States.

(8) CLOSE

If you have any questions, I will be glad to try to answer them in the question period. Thank you.

CHART 1

MILITARY AIRCRAFT OPERATIONS AT SELECTED ATC TOWERS: FY 1976

AIRPORT	OPERATIONS
ANDREWS AFB, CAMP SPRINGS, MARYLAND	148,021
PALMDALE, CALIFORNIA	60,396
CHARLESTON AFB, SOUTH CAROLINA	57,827
NEWPORT NEWS, VIRGINIA	53,709
DOTHAN, ALABAMA	49,496
HONOLULU, HAWAII	43,473
COLORADO SPRINGS, COLORADO	42,550
PUEBLO, COLORADO	39,680
ATLANTIC CITY, NEW JERSEY	38,391
CORPUS CHRISTI, TEXAS	36,930
ALBUQUERQUE INT'L., NEW MEXICO	36,850
RICHMOND BYRD INT'L., VIRGINIA	36,463
BOISE, IDAHO	35,077
NIAGARA FALLS , NEW YORK	32,810
LINCOLN MUNICIPAL, NEBRASKA	31,500

SRI AVIATION FORECASTING MODELS

- Randall J. Pozdena
Transportation Analyst, Transportation Center
Stanford Research Institute (SRI)

The Stanford Research Institute was recently involved in two forecasting efforts for the Federal Aviation Administration. The first involved forecasting peak Instantaneous Airborne Counts (IACs) on a world region basis as part of an aeronautical communications satellite study (AEROSAT). The second involved the forecasting of aircraft activity at various altitudes by aircraft type for various world regions, as part of the High Altitude Pollution Program (HAPP) research.

In both cases, fairly extensive manipulation of basic activity forecasts was required in order to produce the activity measures needed. This put a practical limit on the number of alternative input assumptions that could be economically explored. In addition, 15 and 20 year forecasts were required, making it imperative that changes in technology be explicitly embodied in the forecasting process.

The Forecasting Model

Both of these constraints implied the need to develop a model which required as few input assumptions as possible and which, instead, simulated the market behavior of the carriers under different economic and technological scenarios. The basic forecasting model that was developed requires as input assumptions only the growth rates in the following variables:

- per capita GNP in the origin and destination countries
- population in the origin and destination countries
- aviation fuel prices
- non-fuel air carrier costs

From these input assumptions, the model supplies growth rate forecasts of:

- passenger trips
- flights
- average aircraft size (proxied by seat capacity)

AD-A040 065 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C OFFICE--ETC F/G 5/3
AVIATION FORECASTS FY 1977 - 1988, SUMMARY AND BRIEFING CONFERE--ETC(U)
DEC 76

UNCLASSIFIED FAA-AVP-77-16 NL

2 OF 3
AD
A040065

OF 3

0065

- cost per flight
- average fare
- load factor.

As this list implies, many of the variables that are normally part of <u>input</u> assumptions are endogenous to this model, thereby reducing the input requirements of the forecasting process. If the model of air carrier behavior is sound, this method of forecasting also reduces the possibility of employing inconsistent assumptions in a forecast (such as, for example, an inconsistent assumption concerning load factor, aircraft size, and passenger trips).

The model was econometrically parameterized using a cross-section of route data. The calibrated activity model was then employed to drive other models which generated the specific outputs using Official Airline Guide flight information as an input. The relationship between the econometric analysis and the other models that were developed is illustrated in Figure 1.

Some of the other models developed were the following:

- a charter activity model
- a general aviation activity model
- a fleet transition model which forecasts the evolution of aircraft fleets that result from changing economic and technological conditions
- time/space allocation models

The essential economic structure of the forecasting model is presented in Figure 2. These equations describe the basic behavioral structure employed and, along with assumptions concerning the profit consciousness of the air carriers, yield equations which are capable of being econometrically calibrated. Figure 3 presents some of the quantitative implications of the econometric analysis. It should be pointed out that the various demand and supply elasticities presented are relevant to the demand and supply curves themselves, and not to a reduced form representation on the <u>intersection</u> of demand and supply as is often the case in econometric analyses of the demand for air transport services. This point deserves some clarification.

If a simple regression is performed on passenger trips and fares, using fares as the independent variable, analysts often find that the sign of the coefficient on fare is of the wrong sign (positive instead of negative). This is because this specification of demand ignores the supply-side interaction. For example, a higher fare may induce the air carrier to offer more frequent service which may actually cause passenger trips to increase rather than decrease. In effect, the influence of price on demand for services is offset by the stronger effect of improved service. A simple regression will not "identify" these effects separately; it will yield instead the (counterintuitive) result that an increase in fare increases patronage, everything else being equal.

The model presented in Figure 2 is an attempt to recognize not only the simultaneity of demand and supply factors, but also to recognize the lagged response of fares and fleet decisions.

Using this model of air carrier behavior, forecasts were derived for various important passenger markets. Some of these forecasts are presented in Table 1. It is worth noting that subsequent to the development of this information, IATA has revised its forecast for the North Atlantic upward and it is now nearer the range suggested by the SRI model.

The AEROSAT and HAPP Counting Models

These forecasts were inputs to several counting models which kept track of aircraft activity globally. For the initial AEROSAT work, the Atlantic basin was broken up into 25 rectangular "pseudo FIRs" (flight information regions) as illustrated in Figure 4. The forecast number of aircraft were then "flown" in a computer simulation and various statistics kept on their activity over the basin as a whole and the individual "FIRs." The entries, operations, and flight hours and instantaneous airborne counts were calculated for the busiest Greenwich hours. Table 2 illustrates the output of this modelling process.

In the case of the HAPP research, flight hour activity measures were allocated to various aircraft types, altitudes, and global areas. Special inputs in the form of flight altitude profiles were provided by the FAA for this work. An example of the output yielded by these models is presented in Table 3.

Summary

The research performed by SRI for the FAA has illustrated the usefulness of more complex structural models in aviation forecasting efforts. While the models employed are more complex mathematically and econometrically, they appear to yield plausible and consistent results. When extensive data manipulations are involved, models of the sort described here offer the additonal advantage of limiting the number of input assumptions required to yield useful and consistent results.

SRI is currently installing the full set of models on the FAA's computation system, and developing methods for making the models useful for market-share and regulatory policy analysis.

Figure 1: FAA Counting Methodology

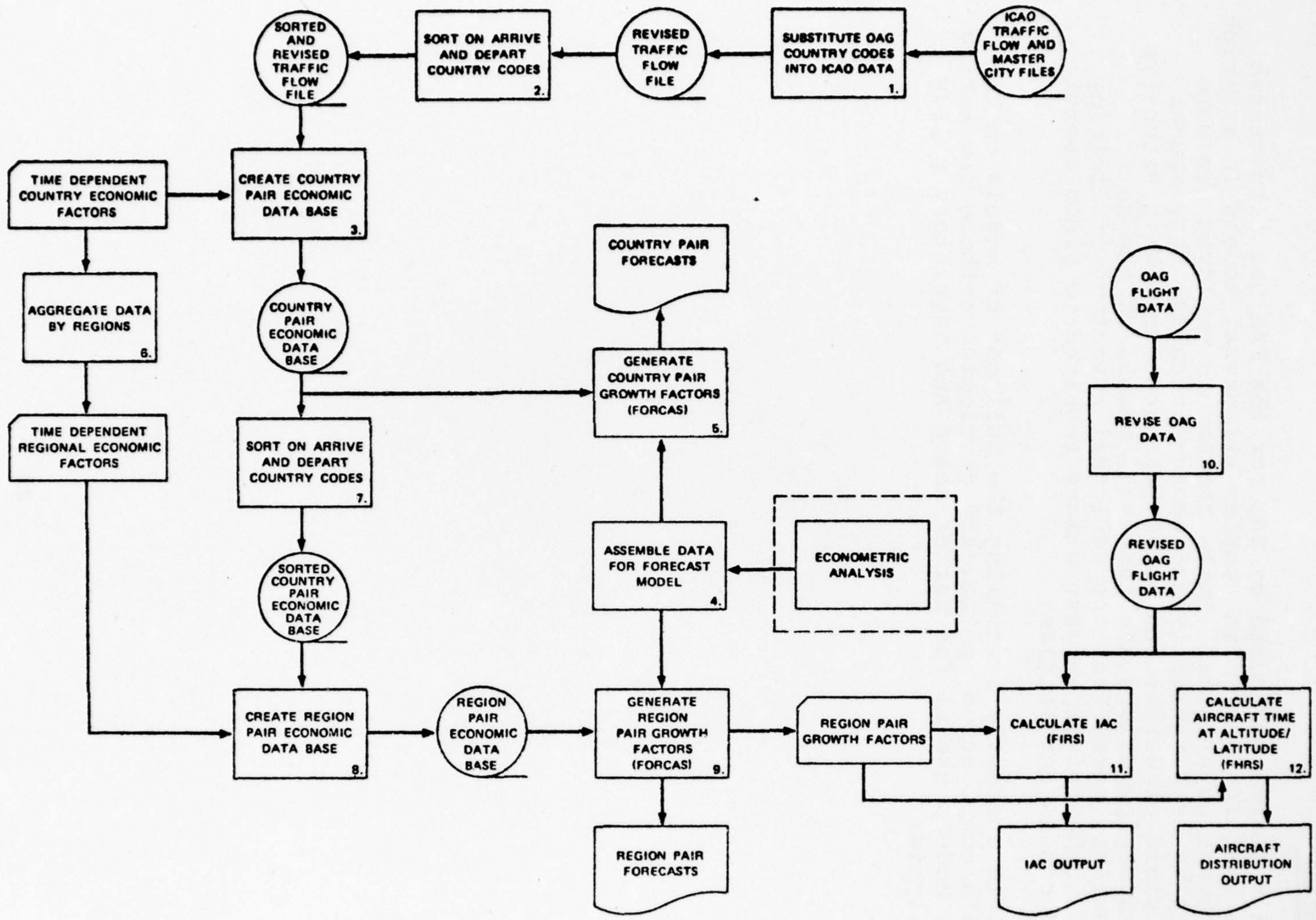


Figure 2

BASIC ECONOMIC STRUCTURE OF SRI AVIATION FORECASTING MODEL

DEMAND RELATIONSHIP: $Q_T = Q_T(P_T, F_T, S_T, Y_T, X_T)$

SUPPLY RELATIONSHIP: $C_T = C_T(F_T, S_T, D_T, G_T)$

LAGGED FARE RESPONSE: $(P_T/P_{T-1}) = F(P_T^*/P_{T-1})$

LAGGED FLEET RESPONSE: $(S_T/S_{T-1}) = G(S_T^*/S_{T-1})$

WHERE: Q_T = NUMBER OF PASSENGER TRIPS IN *PERIOD* T *ON* A PARTICULAR ROUTE

P_T = ACTUAL FARE; P_T^* = THE LEVEL DESIRED BY THE CARRIERS

F_T = FREQUENCY OF SERVICE

S_T = ACTUAL AVERAGE GAUGE OF AIRCRAFT; S_T^* = THE GAUGE DESIRED BY THE CARRIERS

Y_T = PER CAPITA INCOME CHARACTERISTICS OF THE ORIGIN AND DESTINATION INCOME

X_T = POPULATION CHARACTERISTICS OF THE ORIGIN AND DESTINATION COUNTRY

D_T = STAGE LENGTH

Figure 3

SOME IMPLICATIONS OF ESTIMATED MODEL PARAMETERS

RETURNS-TO-SCALE FACTOR = 1.0598

PRICE ELASTICITY OF DEMAND = 0.1915

INCOME ELASTICITY OF DEMAND = 0.2199

POPULATION ELASTICITY OF DEMAND = 0.1359

SIZE ELASTICITY OF FLIGHT COST = 0.7436

DISTANCE ELASTICITY OF FLIGHT COST = 0.8713

FUEL PRICE ELASTICITY OF FLIGHT COST = 0.1055

ELASTICITY OF FARE WITH DISTANCE = 0.8843

FRACTION OF UNDESIRED FLEET THAT CAN BE ADJUSTED IN ONE YEAR = 0.2857

Figure 4 Flight Information Regions

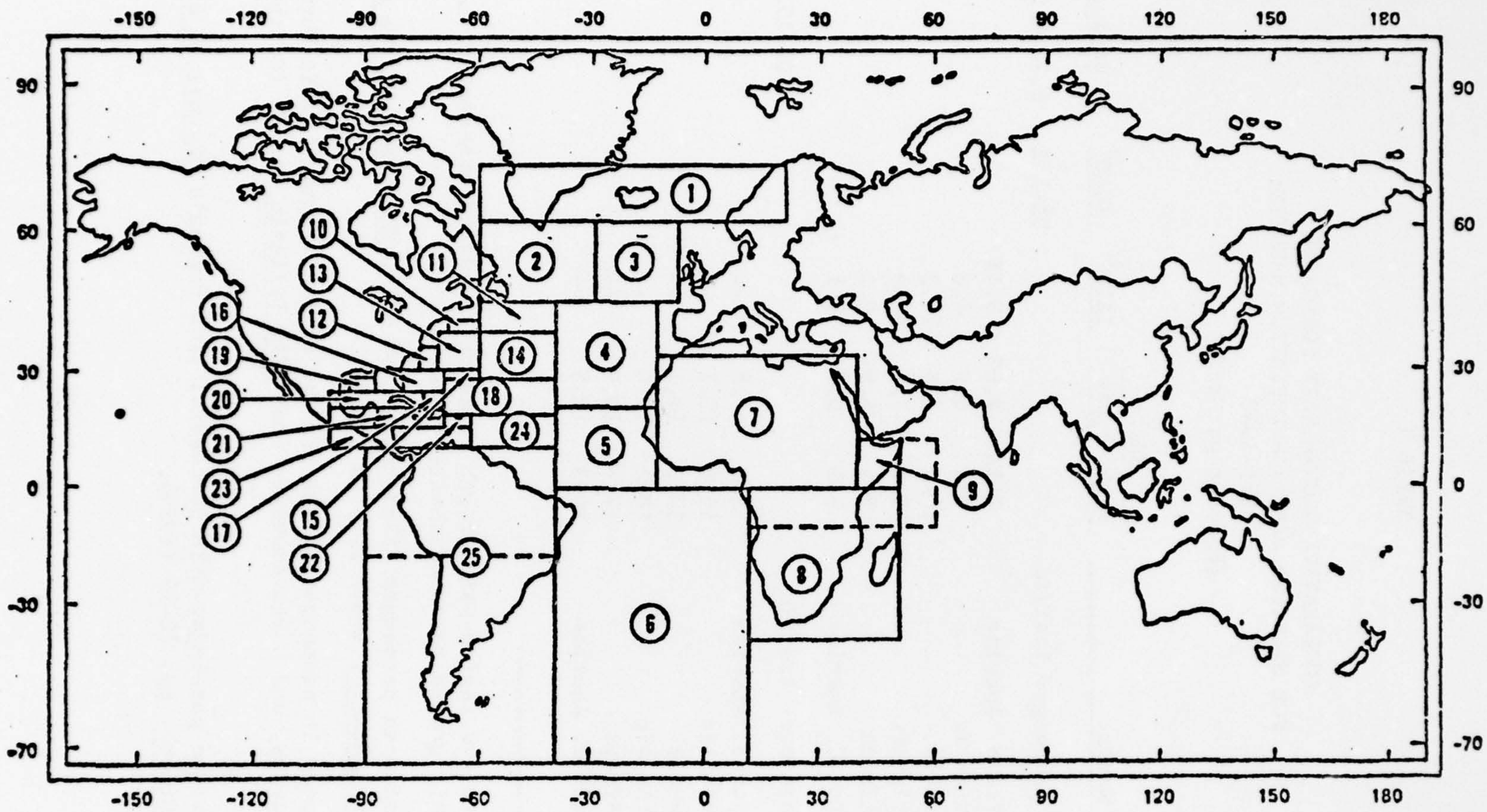


Table 1

COMPARATIVE GROWTH RATE FORECASTS
FOR SELECTED AIR TRANSPORTATION MARKETS:
1975-1980
(Percent per Year)

Market	SRI* High	SRI* Low	IATA†	ICAO‡	Boeing§
Scheduled passenger traffic				8%-10%	6.7%-8.0%
N. America-S. America	8.3%	5.9%	9.4%		
North Atlantic	9.6	6.9	4.8		
Mid Atlantic	10.1	7.5	11.3		
South Atlantic	9.8	7.2	11.9		
Europe-Africa	9.5	6.9	8.2		
N. America-C. America	9.3	6.7	8.1		
Charter passenger traffic					9.0%-15.4%
N. America-S. America	13.8	9.8	--		
North Atlantic	12.8	10.1	--		
Mid Atlantic	18.9	14.1	--		
South Atlantic	18.2	13.4	--		
Europe-Africa	17.6	12.9	--		
N. America-C. America	16.3	11.9	--		

---

*Representative region-pair growth rates of scheduled passengers and region-pair growth rates of charter flights.

†Growth rates in passenger kilometers; from IATA, The State of the Air Transport Industry, Table 7, p. 9 (1975).

‡Growth rates in passenger kilometers for airlines domiciled in Europe, South America, and North America; from ICAO Bulletin, p. 32 (October 1974).

§World revenue passenger-mile forecasts; from Boeing's Dimensions of Airline Growth, pp. 18-19 (1974).

Table 2

ATLANTIC BASIN 6/78 DATA 1978 (ALL TRAFFIC)

TOTAL 12116.6 FLIGHTS

	BUSY ENTRY HR	ENTRIES	BUSY OPS HR	OPS	BUSY FLITE HR	FHRS	IAC FOR BUSY FHR
SYSTEM	14.	870.1	14.	835.5	16.	851.4	874.8
FIR 1	13.	8.1	19.	7.1	18.	16.0	16.9
FIR 2	16.	52.7	4.	51.0	17.	111.4	114.5
FIR 3	4.	58.9	5.	43.6	5.	74.7	79.1
FIR 4	9.	25.8	9.	24.5	3.	19.4	21.2
FIR 5	4.	14.3	4.	11.4	6.	17.9	20.0
FIR 6	20.	31.5	20.	27.4	21.	22.0	27.4
FIR 7	9.	108.0	9.	94.2	9.	84.7	99.5
FIR 8	8.	118.5	8.	120.3	8.	111.3	122.0
FIR 9	7.	5.5	7.	4.6	3.	3.5	3.7
FIR 10	24.	2.0	24.	2.0	17.	.5	1.4
FIR 11	15.	10.0	20.	9.4	18.	6.3	9.8
FIR 12	22.	10.6	22.	7.2	22.	6.5	9.4
FIR 13	15.	24.3	15.	17.5	15.	20.4	24.3
FIR 14	24.	6.2	5.	4.1	5.	5.0	5.2
FIR 15	16.	15.1	16.	13.0	16.	7.1	13.6
FIR 16	20.	73.9	20.	81.1	19.	40.8	46.2
FIR 17	21.	28.2	21.	25.1	19.	13.2	19.9
FIR 18	21.	218.8	21.	212.9	21.	92.4	113.9
FIR 19	17.	8.1	17.	6.4	17.	4.5	5.8
FIR 20	20.	56.6	20.	47.4	18.	35.4	43.2
FIR 21	21.	105.5	22.	103.0	21.	51.6	66.0
FIR 22	14.	84.0	21.	81.6	16.	22.3	33.7
FIR 23	23.	98.2	23.	88.5	24.	43.1	55.6
FIR 24	13.	67.2	13.	65.2	14.	24.4	30.6
FIR 25	12.	249.4	14.	251.5	13.	246.5	256.6

Table 3

NON POLAR FLIGHT HOURS SPENT BY AIRCRAFT TYPE 727 AT ALTITUDE 10000-11000 METERS

LONGITUDE BANDS	LATITUDE BANDS -60	-50	-40	-30	-20	-10	0	10	20	30	40	50
-180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.43	0.00	0.00	0.00	3.76
-140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	21.66	334.54	166.23	23.03
-100	.22	5.78	3.81	4.05	1.98	3.68	2.83	8.45	133.47	975.82	343.39	.88
-60	0.00	0.00	1.79	9.68	20.03	6.36	0.00	.02	0.00	0.00	.40	0.00
-20	0.00	0.00	.32	.53	.10	.44	.75	.83	.55	22.68	102.61	10.58
20	0.00	0.00	4.39	2.35	.06	.32	.07	.56	1.40	8.18	5.94	4.29
60	0.00	0.00	0.00	0.00	0.00	.06	.13	2.54	6.71	.52	.02	0.00
100	0.00	0.00	28.75	2.18	2.42	3.77	3.62	5.88	7.55	20.88	2.62	0.00
140	0.00	.44	11.24	7.64	3.27	.12	.04	.32	0.00	3.02	1.28	0.00
180												

THE LONG-TERM OUTLOOK FOR U.S. SCHEDULED INTERNATIONAL PASSENGER TRAFFIC

- Carl T. Norris
Senior Economist, Market Development
Douglas Aircraft Company, McDonnell Douglas Corporation

We at the Douglas Aircraft Company rely extensively on econometric modeling for our airline demand forecasting. In this case I will present our single equation model and forecast for the scheduled international revenue passenger miles of the U.S. carriers.

The economic scenario upon which the forecast is based is the control solution of the annual Wharton model dated November 1976. This solution forecasts healthy real economic growth for 1976 and 1977 with slowing but positive growth for 1978 and 1979. Another period of slow growth is forecast in the 1982-83 time period. The average annual compound rate of growth in the real GNP for the period 1976-1985 is 3.5 percent. Overall inflation for the U.S. economy is anticipated to be significantly higher than the long-term history. Inflation rates of over 6 percent are forecast for 1977 and 1978 while the average annual compound growth rate for the GNP deflator is 4.7 percent for the period 1976-1985.

One clear advantage to this econometric modeling is the ability to test the effects on traffic of alternate economic scenarios.

TOTAL U.S. SCHEDULED INTERNATIONAL PASSENGER TRAFFIC BEHAVIORAL RELATIONSHIP 1949-1975

This model shows that most of the historical variance of the dependent variable can be explained by the behavior of four independent factors (see Figure 1).

1) Income variable - After considerable testing it was determined that real personal consumption expenditures provide the most explanatory power as an income variable. A distributed lag was applied to this variable so that traffic in time T is a function not only of income in time T but also with declining weights in time T-1, T-2, T-3, T-4 and T-5. The weights assigned were tested with the test criteria being to maximize the goodness of fit of the model. After this was accomplished, a second

transformation was applied. A constant was subtracted from each value of the income time series. This accounts for the occurrence of two phenomena:

a) Market maturation - By subtracting a constant the elasticity of the income variable declines as the value of the variable has increased over time. This declining income elasticity is a method of measuring the maturation of the air travel market.

b) Threshold level of income - The subtracting of a constant also measures the fact that since air travel is a luxury good, there must be some level of income before the first RPM will occur. This constant is the threshold level of income.

A search was performed to determine the value of this constant with the search criteria being to maximize the goodness of fit of the model.

2) Price Variable - The price variable selected is the scheduled passenger yield of the U.S. international carriers. The historical fit of the model is better if this variable is input in real terms. Thus the price of air travel is being compared to the prices of other goods and services available to the consumer. The elasticity of -1.1 is a long term elasticity and pertains to this real yield. Thus, if for example, the current dollar yield increases three percent and overall consumption prices increase four percent, the traffic will increase 1.1 percent, other things being equal.

3) Relative Cost of Living - The purchasing power of the U.S. dollar and inflation abroad has an impact on international travel. This variable compares domestic consumer prices to international consumer prices corrected for exchange rate fluctuations. This was done for the 17 countries most frequented by U.S. citizens with the weight for each country being the relative number of visiting U.S. citizens. The two most important foreign destination countries are the United Kingdom and Mexico.

4) Dummy Variable - Finally, a dummy variable is necessary to correct for a CAB change in definition of international travel which occurred in 1969.

Statistically each variable is significant and the model explains 99.86 percent of the variance of the dependent variable. The Durbin Watson Statistic indicates very little autocorrelation of residuals.

The close fit of the actual and estimated data for U.S. scheduled international passenger traffic is shown in Figure 2. Not only does the model trace the long-term growth pattern, it also captures the major turning point which occurred in 1974.

U.S. SCHEDULED INTERNATIONAL YIELD: CURRENT DOLLARS

In order to forecast the traffic it is necessary to forecast each of the explanatory variables. While sophisticated national econometric models such as Wharton and Chase forecast the economic variables for the U.S. and foreign countries, it is also necessary to input a forecast for the current dollar yield. Unfortunately, efforts to model this variable have proved unsuccessful. The forecast shown in Figure 3 has the current dollar yield increasing at a slightly faster rate than overall inflation. This is due to the following factors:

1) Fuel prices are expected to increase more rapidly than overall inflation in the economy.

2) Labor costs in the airline industry are likely to outpace inflation.

3) These two factors coupled with a forecasted lack of significant productivity increases seem to necessitate that price increases in the industry will be greater than the overall rate of inflation.

U.S. SCHEDULED INTERNATIONAL YIELD: CONSTANT 1972 DOLLARS

The ratio of the current dollar yield to the implicit price deflator for personal consumption expenditures is shown in Figure 4.

U.S. SCHEDULED INTERNATIONAL TRAFFIC: REVENUE PASSENGER MILES

The results of inputting the forecasts of the independent variables into the model is shown in Figure 5. Following two years of substantial decline, the traffic is forecast to increase nearly 10 percent in 1976. This is caused by three primary factors: Healthy growth of the U.S. economy; reduced price of travel in real terms; and increased purchasing power of the dollar particularly in the United Kingdom and Mexico. The healthy economic growth and value of the dollar should continue through 1977 and traffic growth should approximate 8 percent. Thereafter the slowing economic growth and cost induced yield increases should keep traffic growth in the magnitude of 5 percent. The average annual compound rate of growth is 5.9 percent for the period 1976-1985.

FIGURF 1

TOTAL U.S. SCHEDULED INTERNATIONAL
PASSENGER TRAFFIC
BEHAVIORAL RELATIONSHIP 1949-1975

$$\text{LINRPM} = \underset{(T = -0.130)}{-\,0.0959} + \underset{(T = 9.402)}{1.9800\ (\text{LPCE.4.3})} - \underset{(T = -5.267)}{1.1275\ (\text{LINYLD2})} + \underset{(T = 2.184)}{0.3320\ (\text{LUS/FORCT})}$$

$$\underset{(T = -9.183)}{-\,0.1130\ (\text{LDUMMY})}$$

$R^2 = 0.9986$ DURBIN WATSON = 1.8834

S.E. = 0.0165 F STATISTIC (4,22) = 3976.342

WHERE: L = LOGARITHM BASE 10

INRPM = U.S. SCHEDULED INTERNATIONAL REVENUE PASSENGER MILES

$\text{PCE.4.3}_t = \text{PCE}^*_t - 0.30\ (\text{PCE}^*_{t=1949})$

PCE^* = A PERMANENT INCOME MEASURE OF PERSONAL CONSUMPTION EXPENDITURES (CONSTANT 1972 DOLLARS)

INYLD2 = U.S. SCHEDULED INTERNATIONAL YIELD IN CONSTANT 1972 ¢/RPM. DEFLATOR = IMPLICIT PRICE DEFLATOR FOR PERSONAL CONSUMPTION EXPENDITURES

US/FORCT = RELATIVE COST OF LIVING VARIABLE DEFINED

$$\text{US/FORCT} = \frac{\text{PCED}_{U.S.}}{\sum_{i=1}^{17} w_i \text{CPI}_i/\text{XRI}_i}$$

WITH: PCED_{US} = U.S. IMPLICIT PRICE DEFLATOR FOR PERSONAL CONSUMPTION EXPENDITURES

w_i = WEIGHTING FACTOR DETERMINED BY NUMBER OF U.S. VISITORS TO COUNTRY i

CPI_i = CONSUMER PRICE INDEX FOR COUNTRY i

XRI_i = INDEX OF EXCHANGE RATE/DOLLAR FOR COUNTRY i

DUMMY = DUMMY VARIABLE HAVING VALUES OF ZERO FROM 1949-1968 AND ONE FROM 1969-1985. THIS IS TO CORRECT FOR THE DEFINITIONAL CHANGE OF INTERNATIONAL TRAFFIC TO A NON-50-STATE BASIS.

FIGURE 2
U.S. SCHEDULED INTERNATIONAL TRAFFIC
ECONOMETRIC MODEL
GOODNESS-OF-FIT COMPARISON

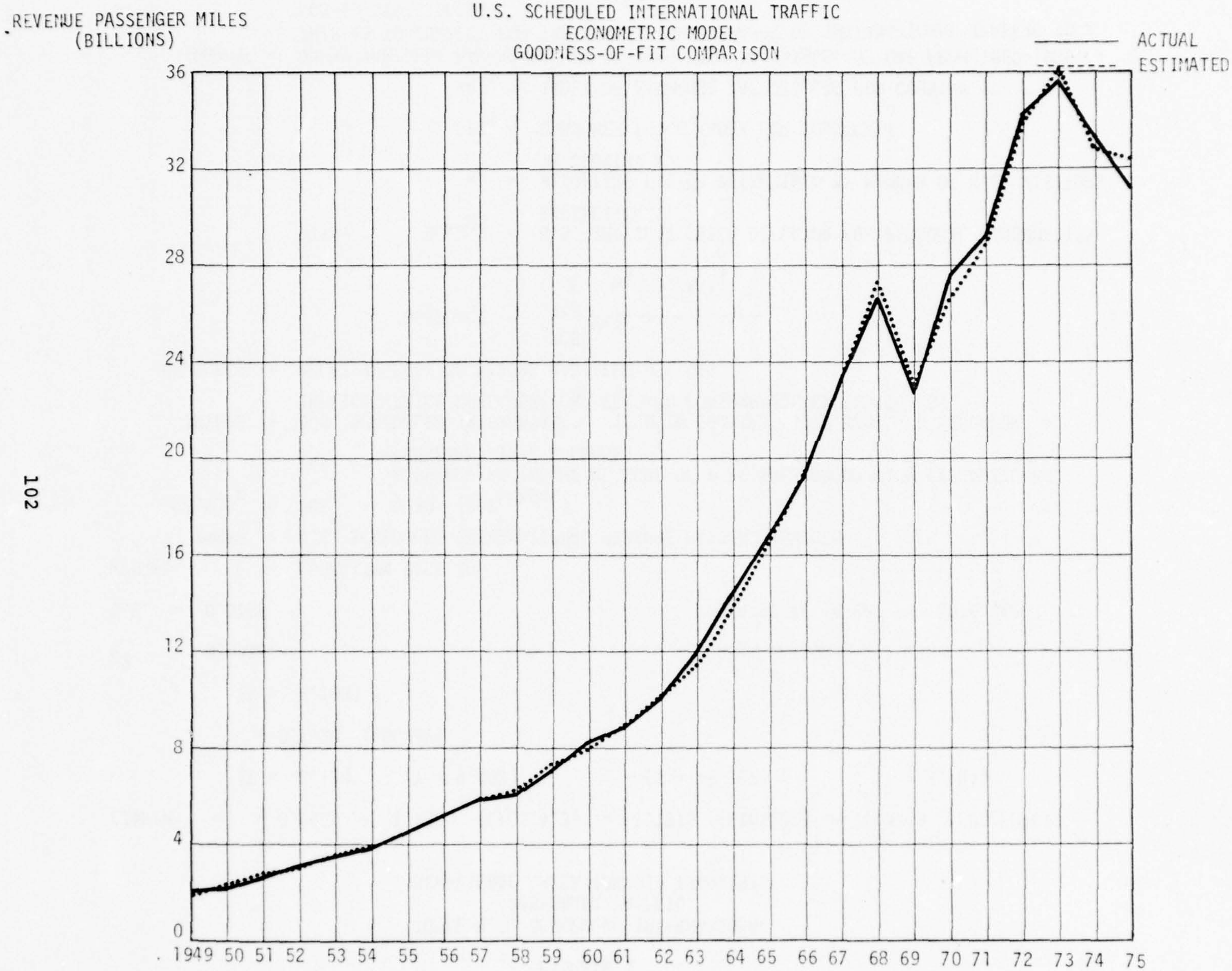
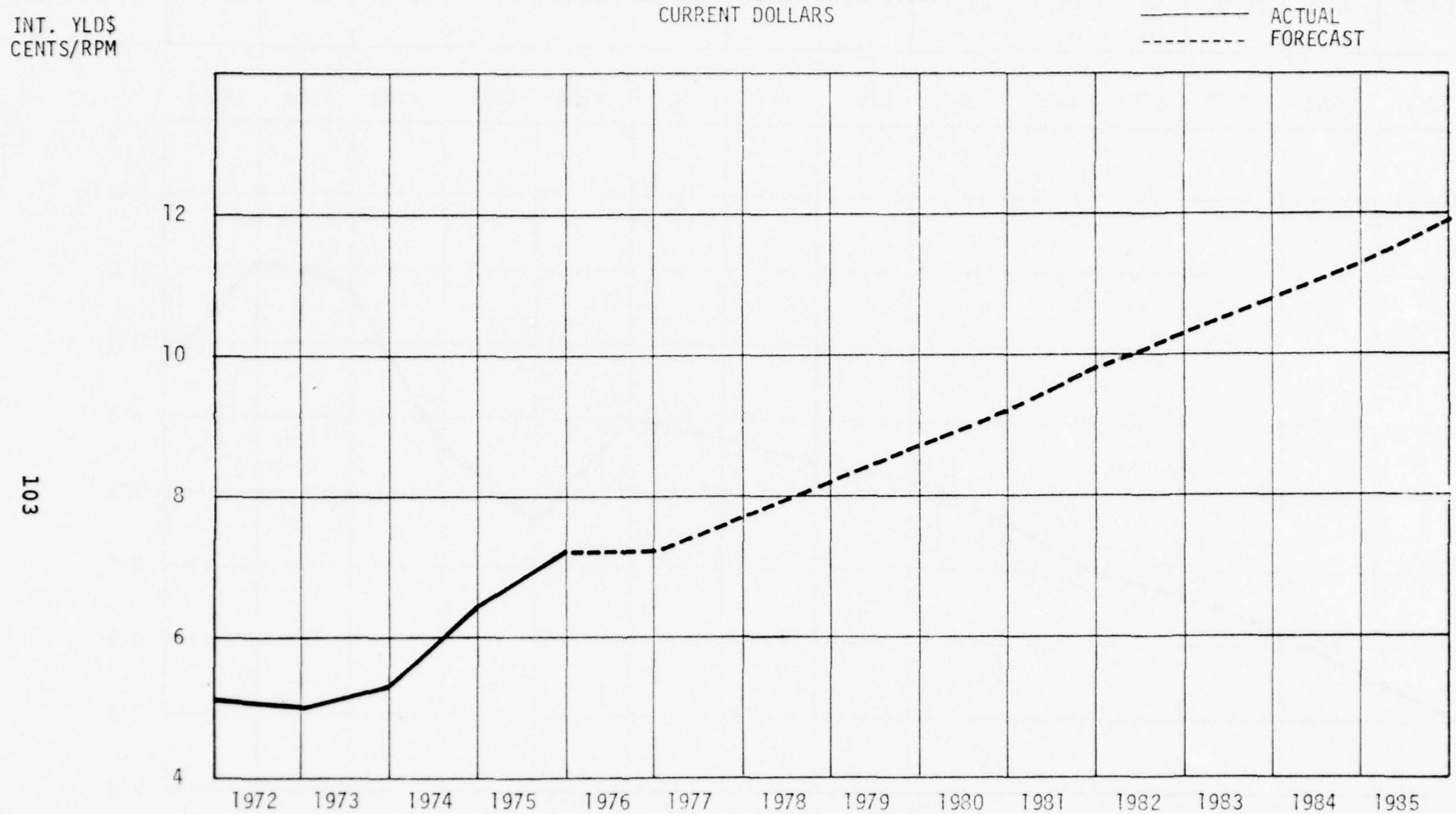


FIGURE 3

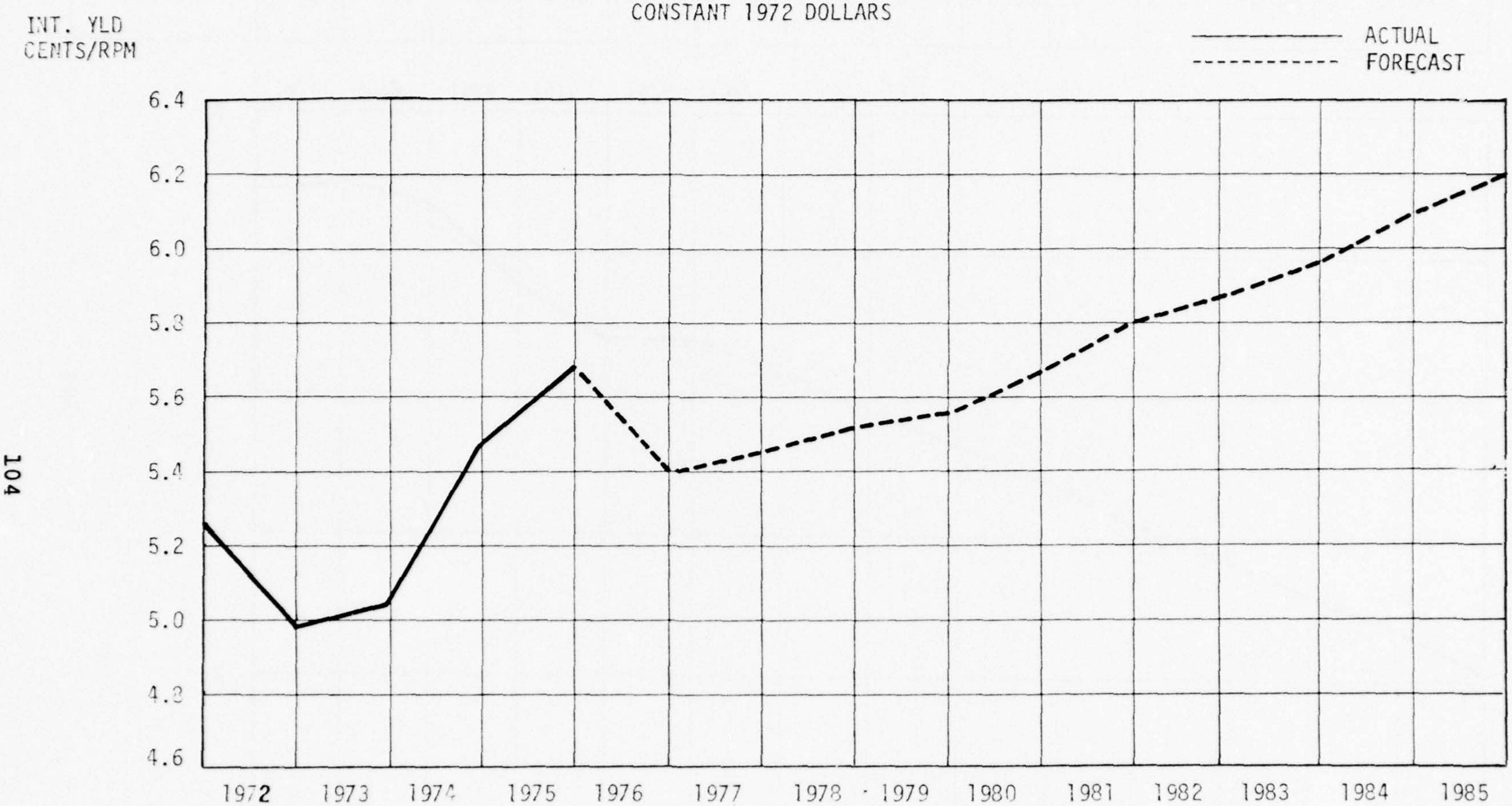
U.S. SCHEDULED INTERNATIONAL YIELD
CURRENT DOLLARS



INT.YLD$	4.98	5.32	6.39	7.18	7.18	7.68	8.22	8.71	9.23	9.78	10.27	10.79	11.33	11.89
% CHANGE	-1.9	6.8	20.2	12.2	0.0	7.0	7.0	6.0	6.0	6.0	5.0	5.0	5.0	5.0

FIGURE 4

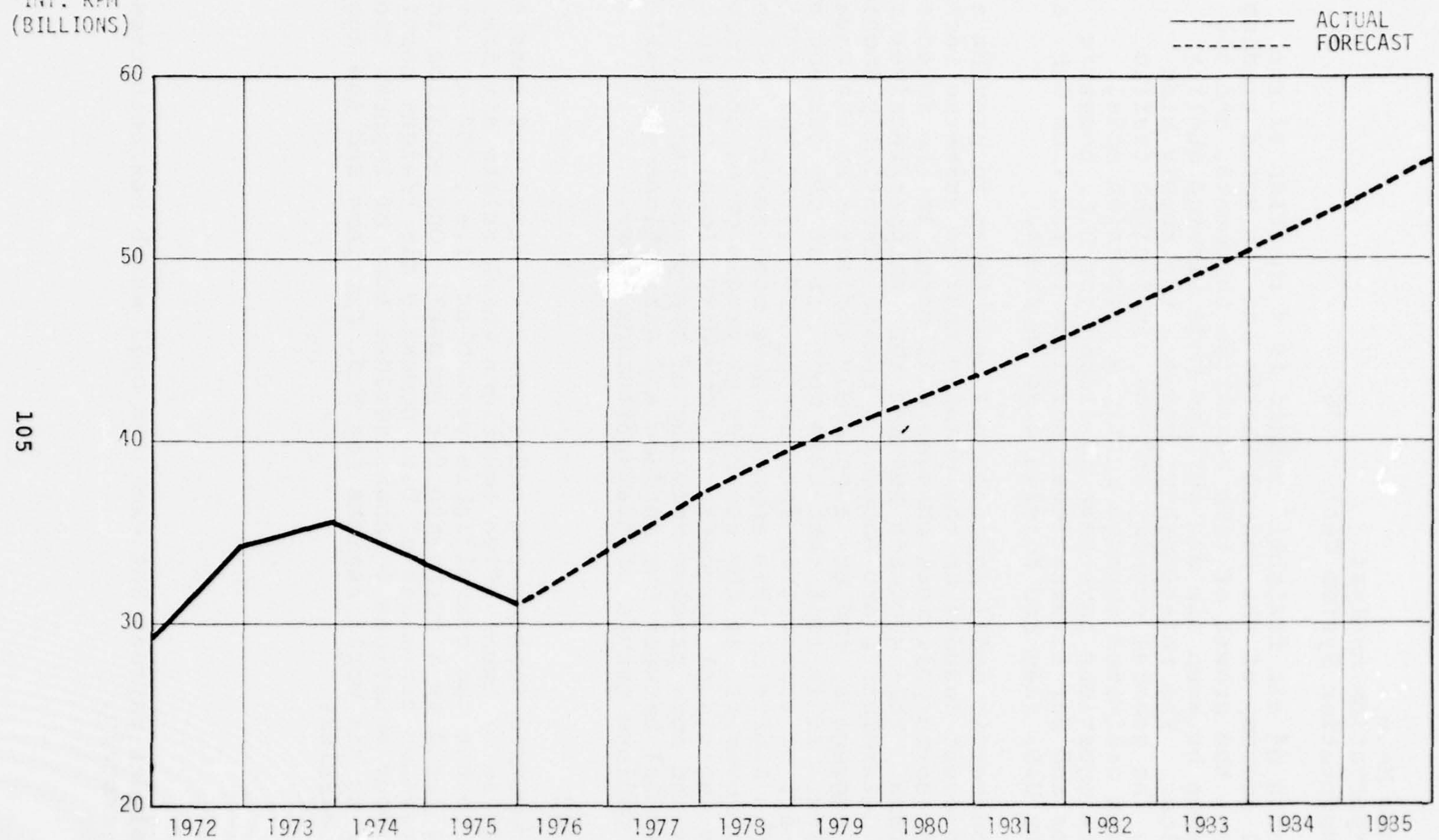
U.S. SCHEDULED INTERNATIONAL YIELD
CONSTANT 1972 DOLLARS



	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
INT. YLD	4.98	5.04	5.47	5.68	5.40	5.45	5.52	5.56	5.67	5.80	5.87	5.46	6.09	6.20
% CHANGE	-5.3	1.2	8.5	3.9	-4.9	0.8	1.3	0.8	2.0	2.3	1.2	1.5	2.1	1.9

FIGURE 5

U.S. SCHEDULED INTERNATIONAL TRAFFIC
REVENUE PASSENGER MILES



INT. RPM	34.3	35.6	33.2	31.1	34.1	37.0	39.6	41.5	43.5	45.7	48.1	50.4	52.8	55.4
% CHANGE	17.3	4.0	-6.9	-6.3	9.7	8.5	7.0	4.7	5.0	5.1	5.2	4.6	4.9	4.8

LONG TERM MACRO AIR FREIGHT FORECASTING

- Domenic Maio
Transportation Analyst
Transportation System Center (TSC)

The growth of air freight[1/] demand is a function of the general economy of the United States and its world trading partners, the growth of time sensitive shipments, and the difference between air and surface mode service quality and prices. The relationships between the supply side prices, the general economy and the air freight traffic have been estimated through multiple regression model. Separate equations have been developed for U.S. domestic services and for international services to and from U.S. airports by U.S. flag and foreign flag carriers.

The econometric model approach has been taken to provide a base forecast founded on the premise that no dramatic technological or socio/political changes will occur in the forecast time frame. This approach assumes that shipper/receiver mode choice determinants are economic, remain essentially unchanged in the aggregate, and are adequately reflected by the equation variables. It is felt that this model is at the current state-of-the-art of econometric forecasting and, given the available data, the limits of this approach have been reached. Significant improvements in the accuracy or precision of the forecasts require individual forecasts of commodity flows, mode split models, and more precise modeling of the price and service differential between the surface and air options available to the various groups of transportation users.

THE MODEL

An econometric forecasting model has been developed consisting of a series of twenty-five equations which relate air freight demand to the two quantifiable variables (i.e., GNP and average revenue yield as a surrogate for prices). One equation forecasts revenue ton-miles of U.S. domestic air freight services. Twenty-four equations forecast revenue tons of imports from and exports to six world regions for U.S. Carriers and the aggregate of all carriers.

1/ Includes express but excludes mail which has been treated separately.

The explanatory variables for the domestic equation are revenue ton-miles and average revenue yields (in constant dollars) for the aggregate of freight and express traffic for all scheduled domestic services reported by the CAB and real U.S. GNP. The time period of estimation is 1950 to 1974. It encompasses substantial variation in economic activity, technological innovation in air service, and an increasing awareness of the benefits of air service to larger segments of the goods distribution industry.

The basis for the U.S. international equation is a ten-year time series (1965-1974) of U.S. exports by air and U.S. imports by air reported by the Department of Commerce and average revenue yields (in constant dollars) for the aggregate of freight and express for all scheduled international services of the U.S. flag carriers. Foreign flag revenue data are not available and it was assumed that average revenue yields would be equal. Unique average revenue yield values between the U.S. and each of the six world regions would have been more accurate but data are unavailable. United States' GNP is used as a variable for imports to the U.S. and an aggregate gross product (in U.S. dollars) for each world region is used for the U.S. exports. Complete documentation of the model and the file of economic and traffic data compiled for the model is contained in a Staff Study paper prepared by the Transportation Systems Center.

THE FORECAST

The base forecast implies a seven percent domestic and nine percent international average annual growth rate over 15 years (see Figures #1 and #2). These growth rates are a function of the model's estimated coefficients and the growth rates of the independent variables. Wharton Economic Forecasting Associates' forecast of U.S. annual GNP (in 1958 dollars) was used for 1975 through 1985. The average annual growth rate of GNP over this ten-year period was used to extrapolate the next five years to 1990 (see Figure #3). The average revenue yield input was projected as constant at the 1974 level on the assumption that the carriers will be able to maintain the real average price of air freight services by countering cost inflation of the factor inputs with efficiency improvements and continued emphasis on passenger fleet lower hold service (see Figure #4). In order to produce high and low boundaries for the domestic forecast, the model was also run with the price surrogate

variable (average revenue yield) projected at a decreasing rate of two percent per year and also at an increasing rate of two percent per year. The domestic low forecast is equivalent to a fifteen year average annual growth rate of three percent and the domestic high forecast is equivalent to about eleven percent (see Figure #5). A more optimistic GNP forecast will of course raise the level of the forecasts.

Whereas revenue ton-mile is the common unit of measure of total airways activity, enplaned tons is a more direct measure of airport cargo activity. In international service this activity will continue to be dominated by Foreign Flag carriers (see Figure #6). Time series continuity of available data more than any other factor dictated the unit of measure for the dependent variables in the forecast model equations. Trends in average haul distances were projected for the forecast time frame to provide the conversion factors between revenue ton-miles and enplaned tons. The domestic average haul projected was a simple extrapolation of the domestic service historical trends. The U.S. international exports and imports average haul projections were the individual products of estimates of the average haul to each aggregate world region in 1974 and the forecasted export tons to and import tons from each region summed over all regions and subsequently divided by the sum of all export tons and of all import tons, respectively. Average haul for domestic and international service is increasing, therefore, revenue ton-miles tend to increase at a faster rate than enplaned tons (see Figure #7).

Cargo activity at airports is currently dominated by the domestic movements (nearly 80 percent of total enplaned tons). The forecast results indicate that the greater growth rate of the international services will increase the international cargo activity from twenty percent to thirty percent of the total enplaned tons by 1990 (see Figure #8). This represents at least a 300 percent increase in international tonnage to be handled at U.S. airports in the fifteen year period, while the domestic tonnage is forecasted to double.

II. PROJECTION OF CARGO ACTIVITY AT U.S. AIR HUBS

Cargo related air and ground activity at U.S. air hub airports is the result of a derived demand. This hub demand is generated by the national aggregate demand for air distribution of commodities. Price and quality of service offered by each

of the freight modes determine the quantity of goods shipped by air versus the other modes. Combination Passenger/Cargo Carriers dominate the U.S. domestic and U.S. international markets. This group of carriers has been emphasizing the cargo capability of their scheduled wide body passenger fleets since this equipment was first introduced. Cargo service provided by these carriers is the product of the fleet equipment mix, route assignment, and flight scheduling which in turn are dictated by passenger service requirements. Freighter (or all-cargo) services are provided only in markets served by the All-Cargo Carriers and in those markets where the Combination Carriers are not able to adequately service the cargo demand with the passenger fleet. It is expected that the air carrier industry will be economically motivated to continue this current policy during the next ten years (see Figure #9).

Long term, macro, national air freight and air mail demand forecasts can be translated into cargo enplanement projections and freighter operations at specific U.S. air hubs. This allocation can be performed for each cargo element (freight, express and mail) and for each of the domestic and international services. At each hub the cargo demand can be allocated to this projected passenger flight lower hold capacity available to that hub in accordance with a projected enplanement load factor unique to that hub. The residual cargo demand can then be allocated to freighter flights. This residual demand, to be enplaned in freighters, can then be translated into freighter departures in accordance with estimates of equipment size and enplanement load factor. Systemwide estimates are inputs which the model translates into hub unique values. Foreign flag as well as U.S. flag carrier activity can be included in the estimates of international activity at U.S. air hubs.

The approach outlined above has been followed in developing the FAA/TSC forecasting methodology and base forecasts presented below. Detailed documentation is contained in two TSC Staff Study papers, "Forecasting Models and Forecasts of U.S. Domestic and U.S. International Air Freight Demand" and "Projection of Cargo Activity at U.S. Air Hubs".

THE METHODOLOGY

The air cargo hub activity projection computer program accepts as input several exogenous files of historical data and forecasts. It produces projections of passenger

flight departures, enplaned tonnage in lower holds, freighter flight departures, and enplaned freighter cargo tonnage at each air hub of interest. The required inputs are: 1) CAB Airline Service Segment data tapes for a base period; 2) a passenger enplanement forecast for each hub of interest for each of three forecast years; 3) a cargo* enplanement forecast for each hub of interest for each of the three forecast years; 4) a set of projections of system average passenger and freighter flight capacity measures (see Figures 10, 11 & 12); 5) a set of system average enplanement load factors for passenger decks, for lower holds and for freighters (see Figure 13). Separate domestic and U.S. international measures of all but the first input are required by the model.

Forecasts are produced for domestic services and for U.S. international services** for each of the three forecast years for each air hub specified. An aggregate forecast for the listed hubs is also provided. (Any number of hubs may be included in the forecast, but only 25 large hubs have been included in the current base forecast.) A set of 43 tables of data is also produced for detailed analysis of intermediate calculations and evaluation of the final forecasts. Included in these tables are actual operating statistics developed from the airline service segment data for the base period.

Preparation of the hub cargo enplanement forecasts for the domestic and international services from the macro forecasts (an exogenous input) is explained in detail in the TSC Staff Study Paper, "Projection of Cargo Activity at U.S. Air Hubs". Briefly, tables of hub shares of national aggregate enplanements (for domestic services and for international services) have been prepared from CAB airport activity statistics and from Department of Commerce Exports by Air Statistics and have been projected as being unchanged during the forecast period. These market shares may be varied for each forecast year if independent analysis indicates significant trends for one or more of the hubs, or for one or more of the services. Hub shares for domestic services, international services, freight (including express) and mail are estimated separately. The separate elements of "cargo" (i.e., freight, express and mail) are aggregated for the domestic and for the international services just before input into the computer program.

---

* Including Freight, Express and Mail

** Including all scheduled and non-scheduled U.S. flag and foreign flag activity.

Allocation of cargo enplanement tons to the passenger fleet lower holds and determination of residual demand for the freighter fleet at each hub is performed in a complex manner which is detailed in the TSC Staff Study Paper. Briefly, a series of direct and indirect measures of equipment mix, route assignment, scheduling and capacity utilization are computed for the base year using service segment data. These measures are then projected for each hub in a manner consistent with the trends projected for the system. By this process, excess passenger fleet lower hold capacity (in heavy passenger markets with low cargo demand) is precluded from consideration for cargo. Hub unique load factor for passengers, lower hold cargo, and freighter cargo are calculated from base year service segment data. Hence, the entire capacity of flights departing a hub is not necessarily available to the cargo demand at that hub. Many hubs, because of their geographical position in the network and/or because of incompatibility of schedules of certain flights with cargo demand, use only a small percentage of the theoretical capacity departing that hub.

THE HUB FORECAST

The hub base forecast for 1977, 1982 and 1987 are produced from the inputs listed in the attached tables through the computer program described above. Tables list the forecasts of enplaned passenger and enplaned cargo tons for domestic and international services for each of twenty-five large hubs. The growth rates implied by these hub forecasts reflect the U.S. total growth in enplanement tons of about five percent per year in domestic services and about eight percent per year in international services (see Figure 7). The international forecasts include the activity of the foreign flag carriers as well as the U.S. flag carriers at these hubs. The passenger enplanement forecasts represent only scheduled services whereas the cargo enplanements represent the aggregate of scheduled and non-scheduled services. It is assumed that the scheduled passenger services will continue to provide the useable lower hold capacity.

Tables in the reference paper list a series of airport activity measures as well as capacity and capacity utilization ratios for the twenty-five large hubs. The values shown have been calculated from service segment data for the twelve month period ending March 1975. (The latest period available at the

start of the project.) Base values for average capacity per departure ratios and average enplaned load factor values are projected for the forecast years. They are projected individually for each hub by the computer program. The growth trends for these individual ratios are consistent with the growth trends for the system as a whole. In addition, they reflect the network interrelationship of the hubs. System average values are the inputs to the program. Inputs used for the base forecast are listed on Figure 13.

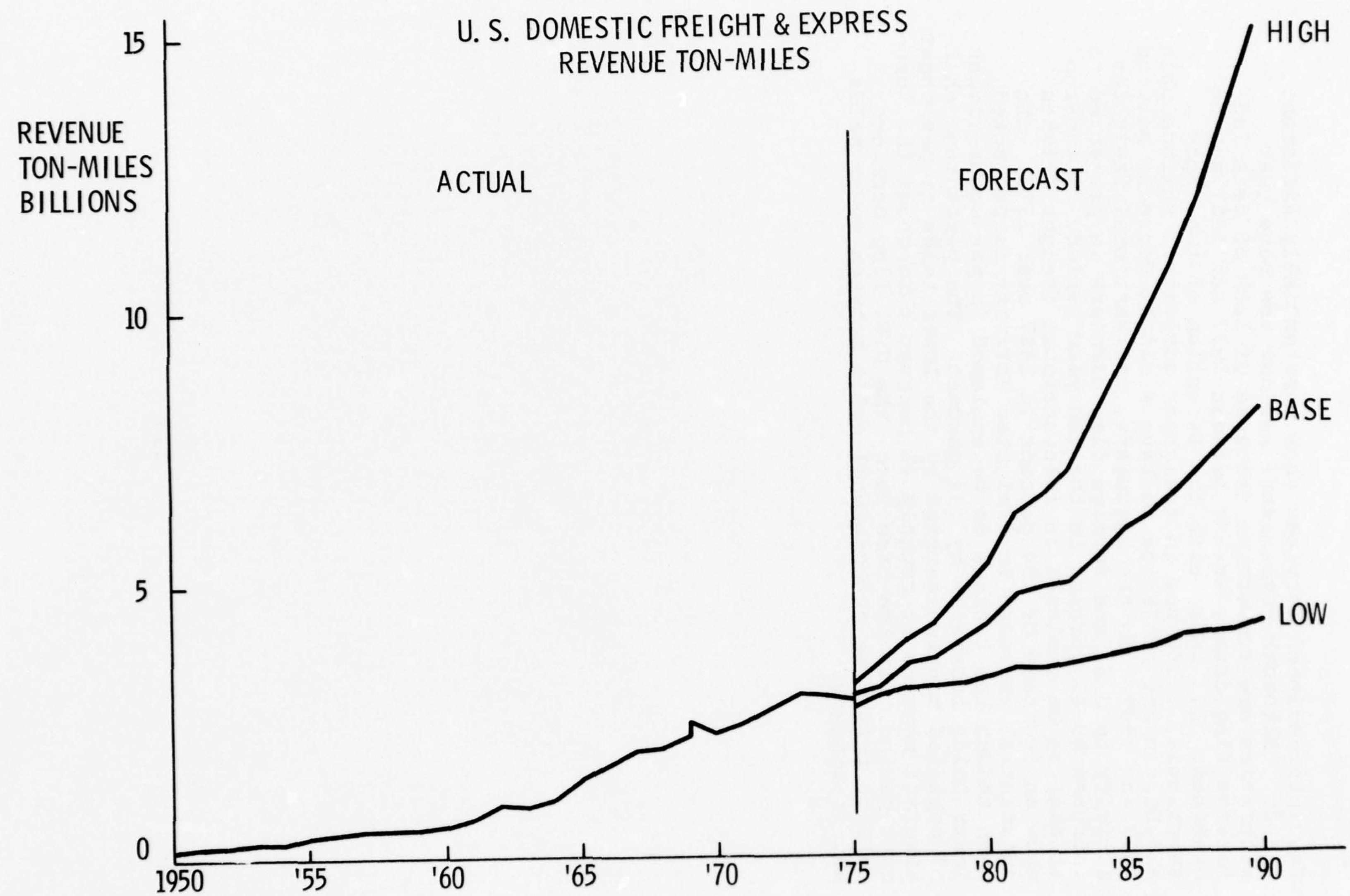
These projections of average airplane size and average enplanement load factor were derived by concensus among the principle analysts and the project managers at TSC and FAA. The average size of passenger aircraft in domestic service is projected to increase by 43 percent between the base year and 1987 while only a modest increase in passenger enplanement load factor* from 47.6 percent to 52 percent is projected. Capacity for aircraft in international service is projected to increase by 32 percent while the system enplanement load factor is projected to increase from 46.2 percent to 52 percent. The passenger fleet lower hold capacity is computed by the program. The lower hold cargo enplanement load factor is projected to increase from 18.5 percent to 24 percent in domestic service, and from 26.9 percent to 40 percent in international service. The average size of freighter is projected to increase 17 percent in domestic service and 29 percent in international service over the forecast period.

The base forecasts are shown in Tables in the referenced paper for the twenty-five large hubs individually and for the aggregate. Among the hubs, the trends vary somewhat. All hubs show a downward trend in domestic freighter departures except San Francisco/Oakland which shows a slight upward trend. In the aggregate, a 37 percent reduction is forecast for domestic freighter departures between the base year and 1987. By 1977 freighter departures are forecasted to drop by approximately 23 percent (see Figure #14). The cargo tonnage enplaned on domestic freighters, however, decreases by only four percent from the base year to 1987. There is forecast to be a 136 percent increase in enplaned cargo tonnage in the lower holds of passenger aircraft (see Figure #15). The lower hold percentage share of total domestic tons enplaned is projected to increase from 64 percent in the base year to 81 percent in 1987.

* That portion of the theoretical capacity departing the hub which is utilized by that hub. The system average enplanement load factor is usually slightly lower than the CAB system on-board load factor. (Revenue Passenger-miles or Revenue ton-miles divided by Available Passenger-miles or Available ton-miles).

The international services show substantially different trends. Although comparisons against the base year statistics are cumbersome (because of lack of detailed foreign flag data), trends between 1977 and 1987 may be examined. All hubs, with the exception of two, show substantial increases in freighter activity. Philadelphia and Boston are projected to have a slight decrease between 1977 and 1987. In the aggregate, international freighter activity by U.S. and foreign flag carriers is projected to increase by 45 percent in the ten year period. The cargo tonnage to be enplaned in international freight flights show an increase of 104 percent in 1987 over 1977. The substantial increase in freighter activity is projected even though the tonnage to be enplaned in passenger flight lower holds increases by 134 percent. The percentage share of enplaned tonnage carried by the lower holds of passenger aircraft remains at roughly 45 percent throughout the forecast period. In the base year, the U.S. flag carriers reflect this same proportional split between lower holds and freighters.

FIGURE 1



U. S. DOMESTIC FREIGHT & EXPRESS
REVENUE TON-MILES
REVENUE
TON-MILES
BILLIONS
ACTUAL
FORECAST
HIGH
BASE
LOW
15
10
5
0
1950
'55
'60
'65
'70
'75
'80
'85
'90

Figure 2

U. S. INTERNATIONAL FREIGHT & EXPRESS
EXPORTS AND IMPORTS

ALL CARRIERS

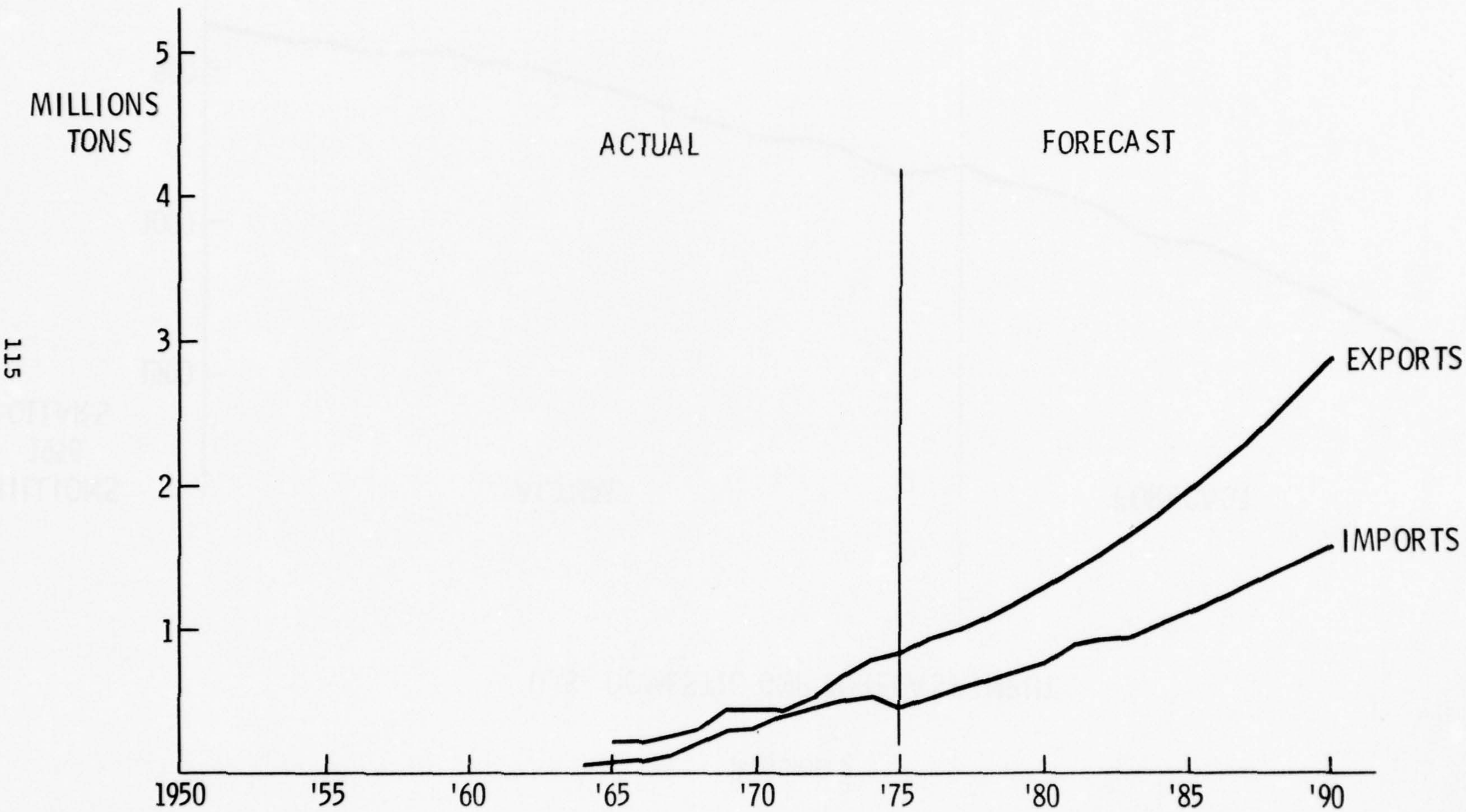


FIGURE 3

U. S. DOMESTIC GNP FORECAST INPUT

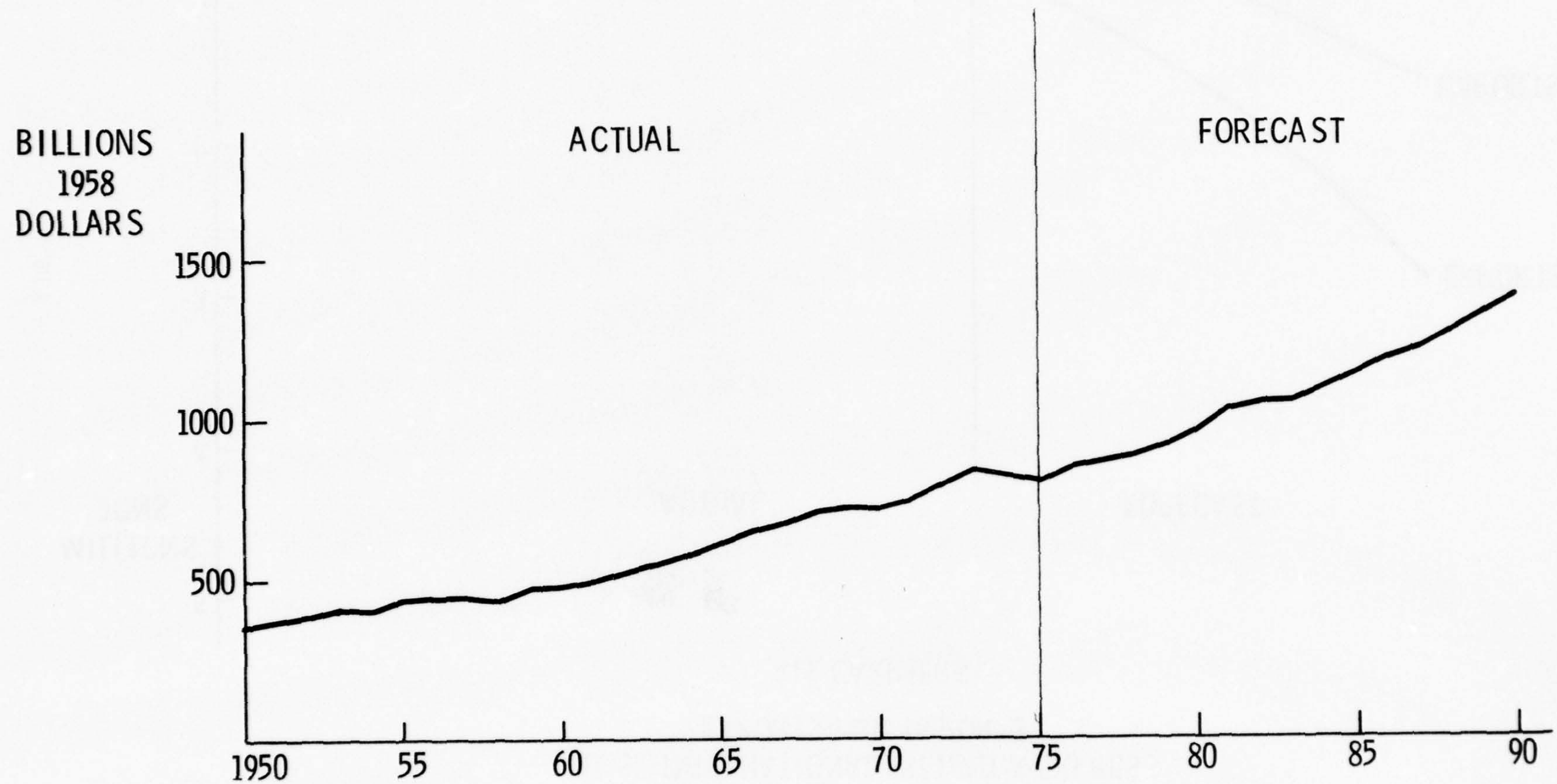


FIGURE 4

U. S. DOMESTIC FREIGHT & EXPRESS
AVERAGE REVENUE YIELD INPUT

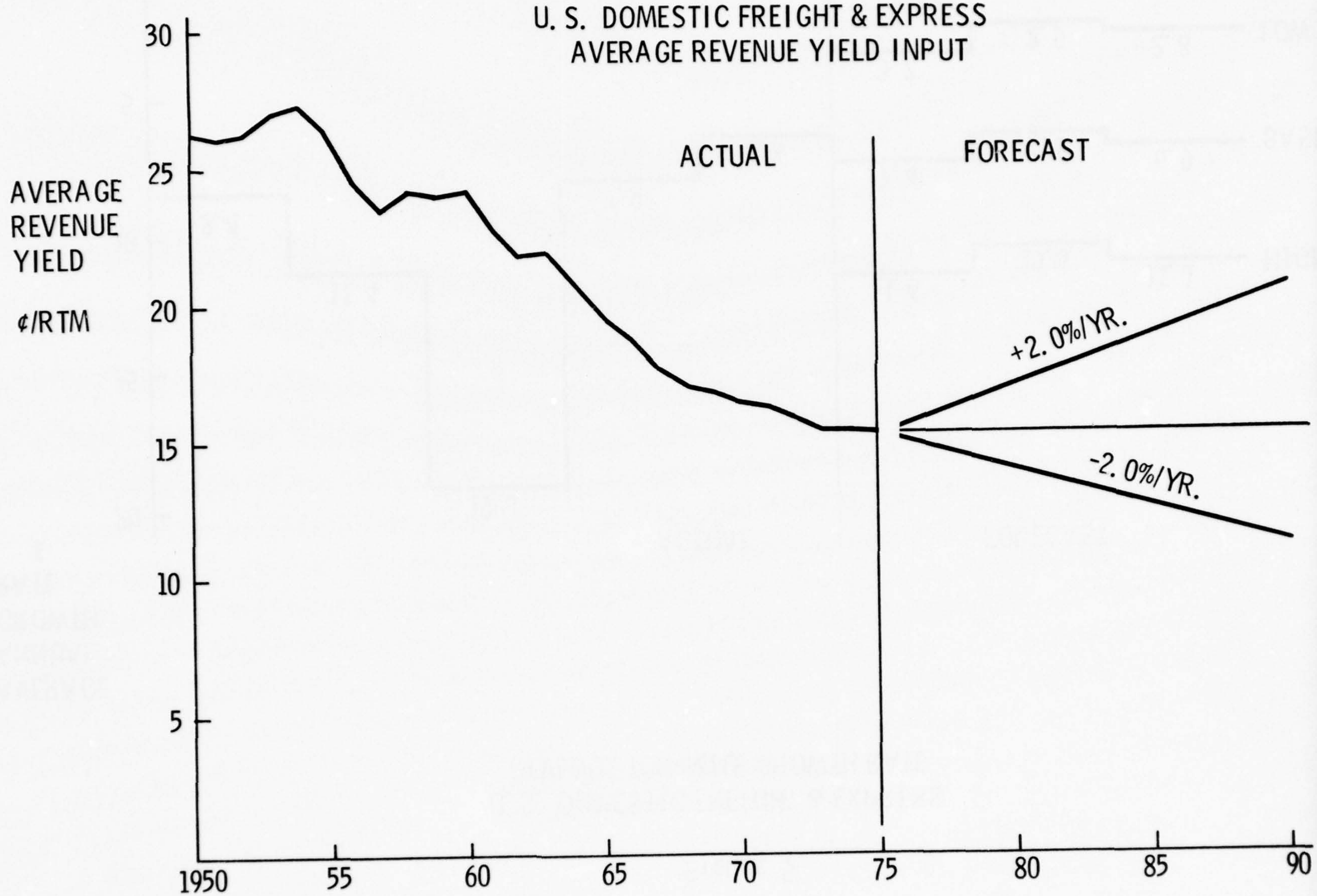


FIGURE 5

U. S. DOMESTIC FREIGHT & EXPRESS
REVENUE TON-MILE GROWTH RATE

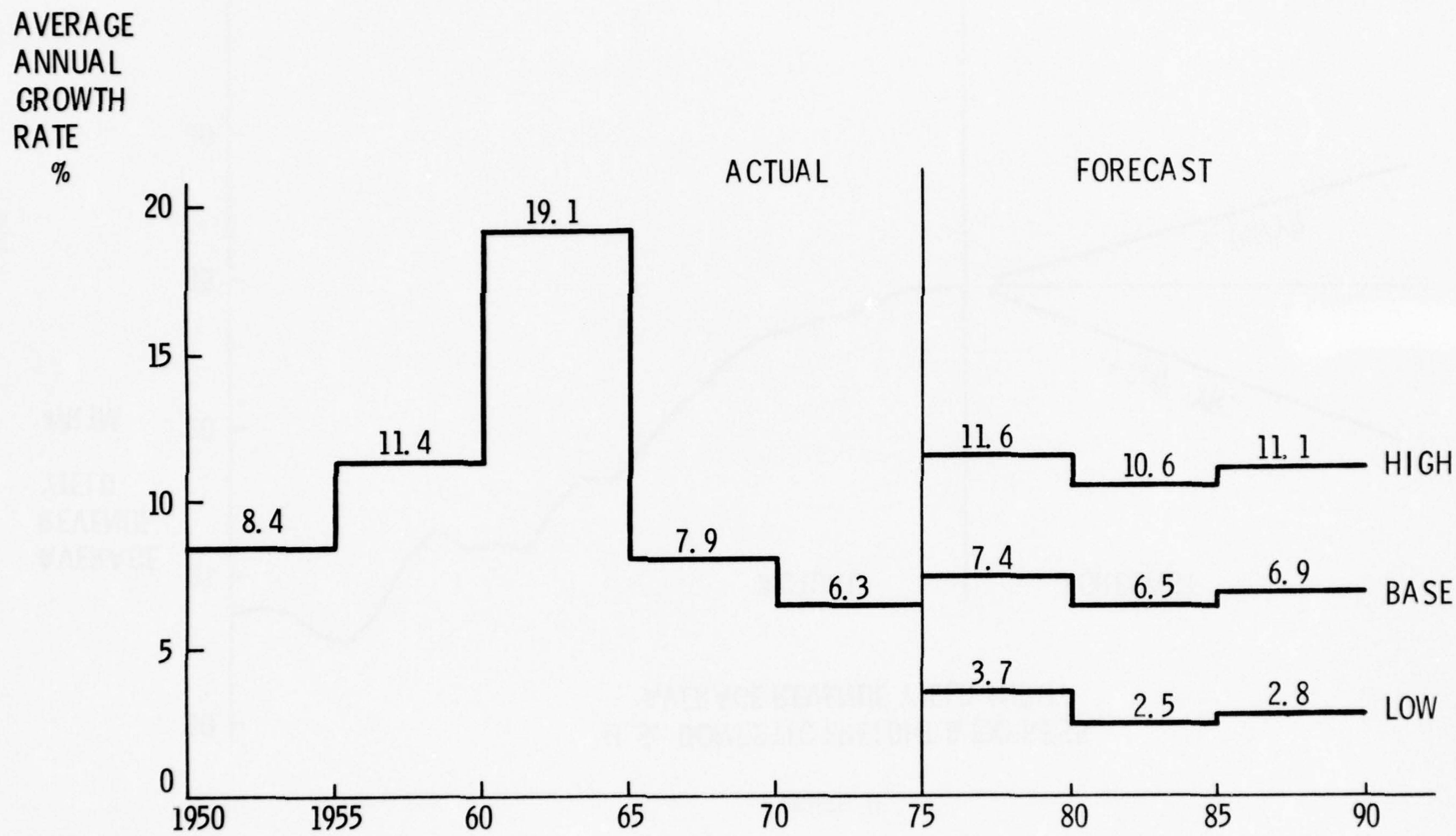


FIGURE 6

U. S. INTERNATIONAL FREIGHT & EXPRESS

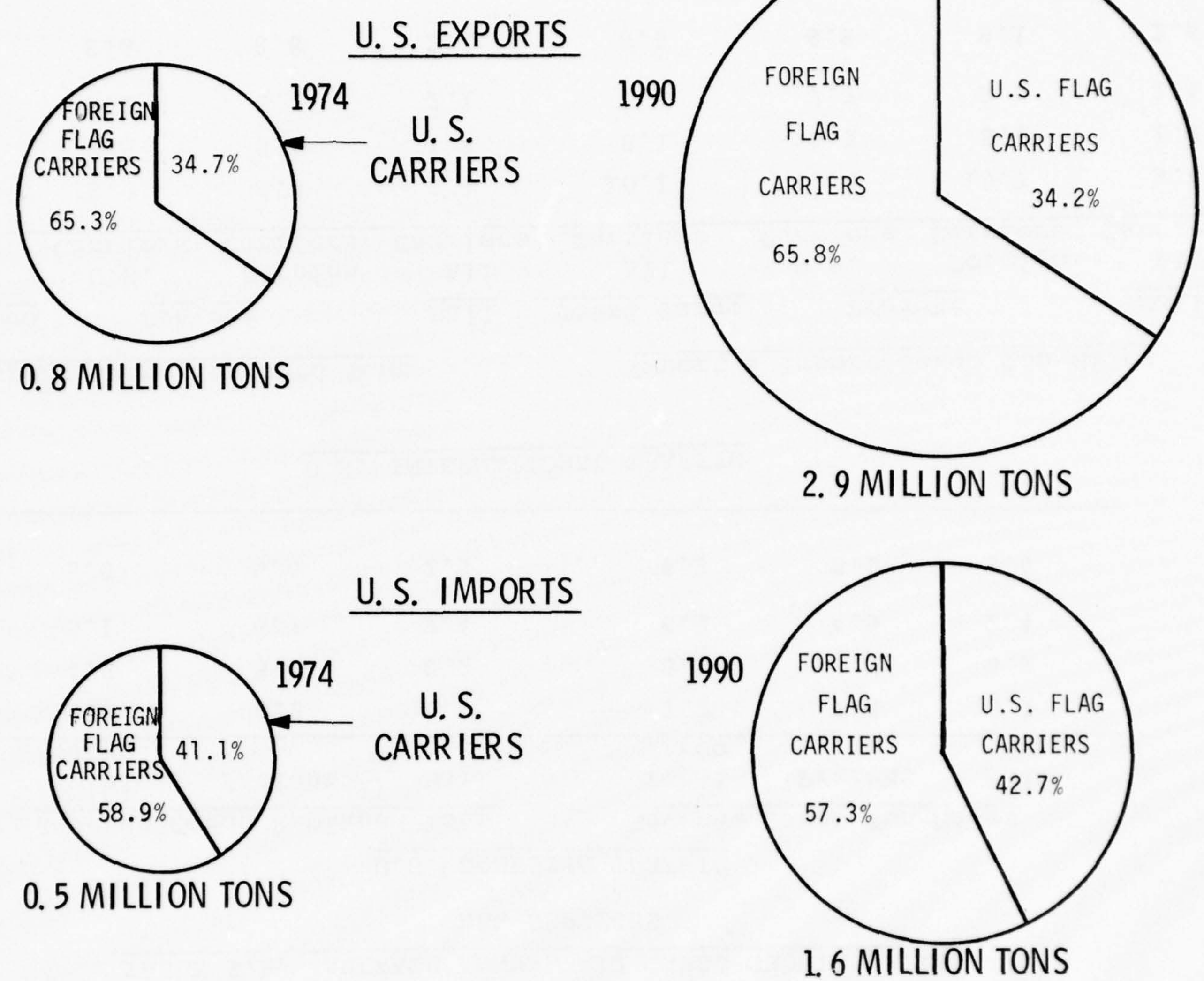


FIGURE 7

TABLE 5.7: AVERAGE ANNUAL AIR CARGO GROWTH RATES

ALL SERVICES

U.S. DOMESTIC TRAFFIC

	Revenue Cargo Enplaned Tons			Revenue Cargo Ton-Miles		
	Total Cargo	Freight (1)	Mail	Total Cargo	Freight	Mail
1975 - '80	5.8	6.2	4.9	7.2	7.4	5.2
'80 - '85	4.2	5.2	0.2	5.5	6.5	0.2
'85 - ' 0	5.1	5.7	2.4	6.3	6.9	2.4
'75 - '90	5.0	5.6	2.5	6.3	6.9	2.6

U.S. INTERNATIONAL TRAFFIC

	Export Cargo Enplaned Tons				Export & Import Cargo Ton-Miles			
	Total Cargo	Freight		Mail	Total Cargo	Freight		Mail
	All Carriers	U.S. Carriers	Foreign Carriers	All Carriers	All Carriers	U.S. Carriers	Foreign Carriers	All Carriers
1975 - '80	8.6	9.0	9.4	3.1	10.1	10.4	10.7	3.4
'80 - '85	8.0	8.5	8.6	1.4	8.1	8.2	8.6	1.8
'85 - '90	7.8	8.2	8.2	2.1	7.7	7.7	8.0	2.4
'75 - '90	8.1	8.6	8.8	2.2	8.6	8.8	9.1	2.6

(1) Includes Express

Figure 8

U. S. AIRPORT CARGO ACTIVITY

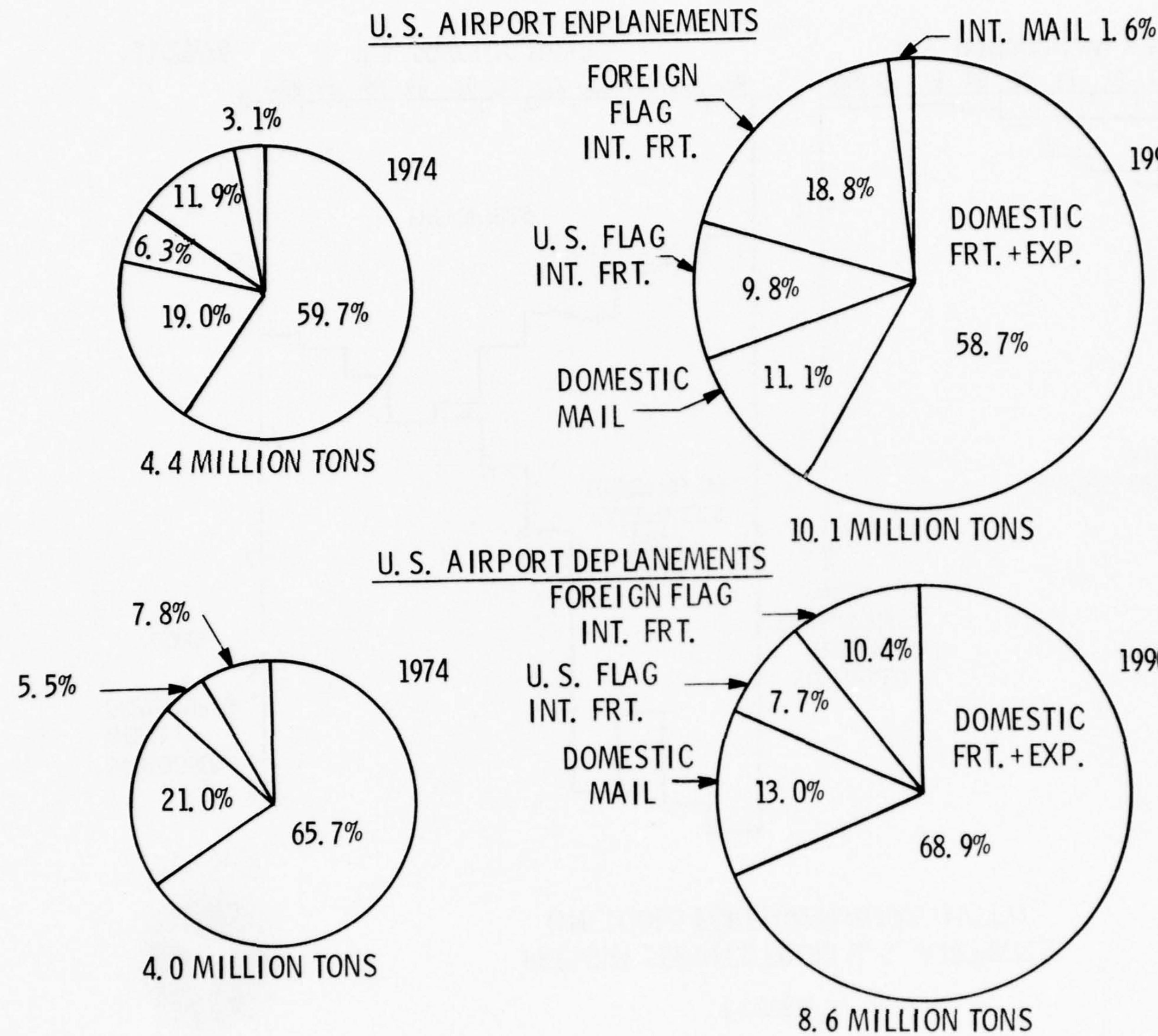
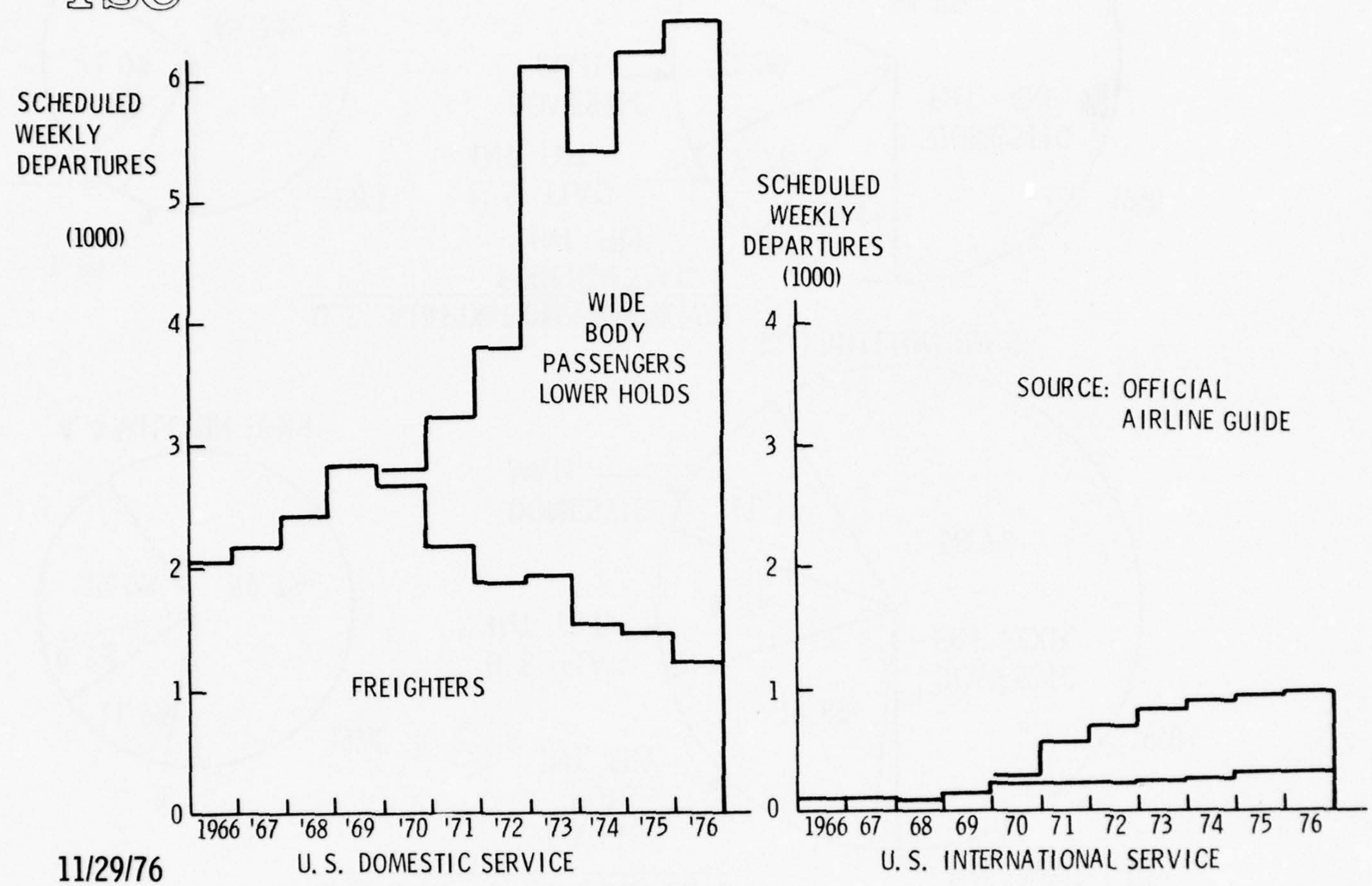


Figure 9

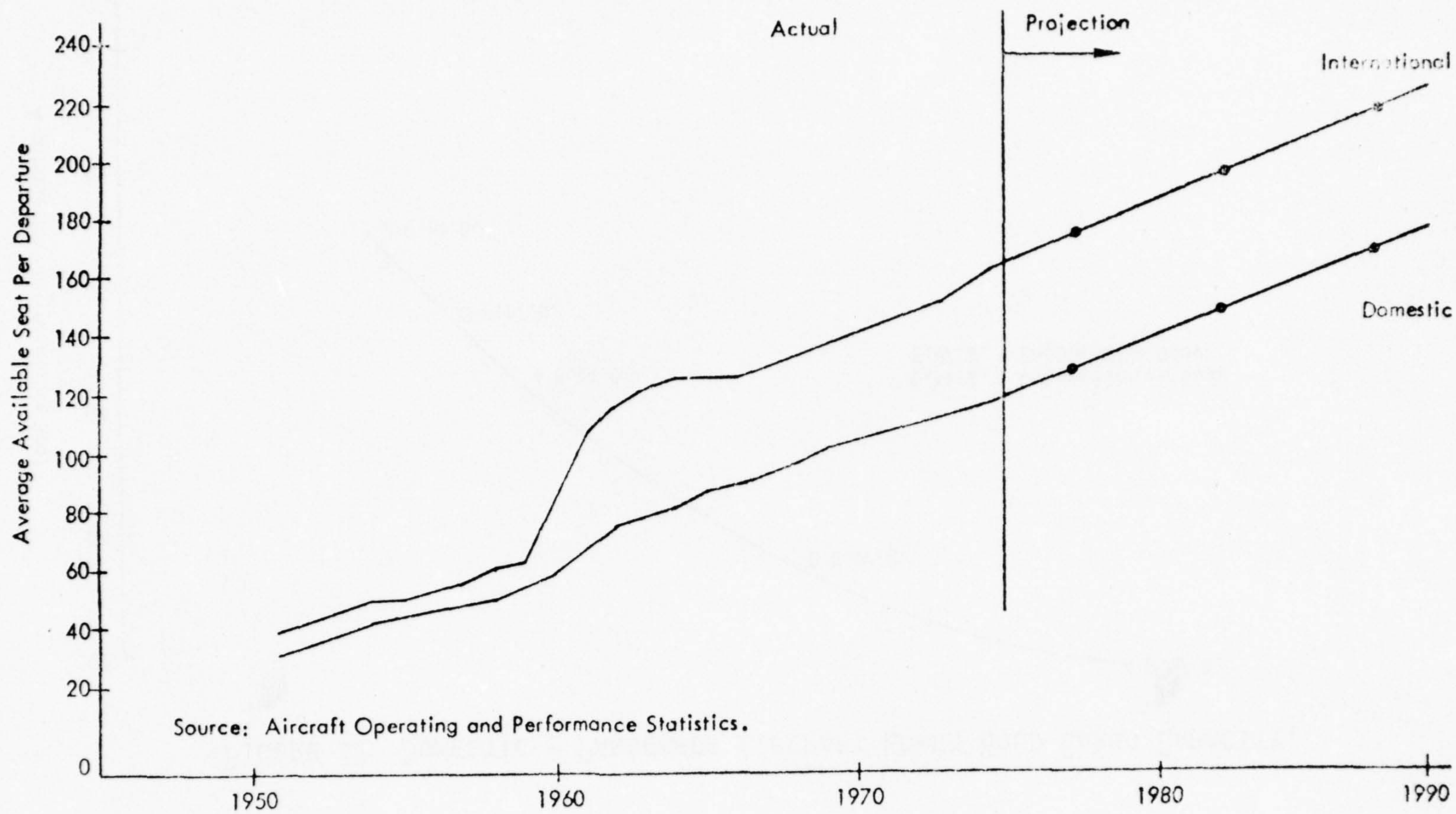
FREIGHT SERVICE FROM U.S. AIRPORTS
(INCLUDES FOREIGN FLAG ACTIVITY)



11/29/76

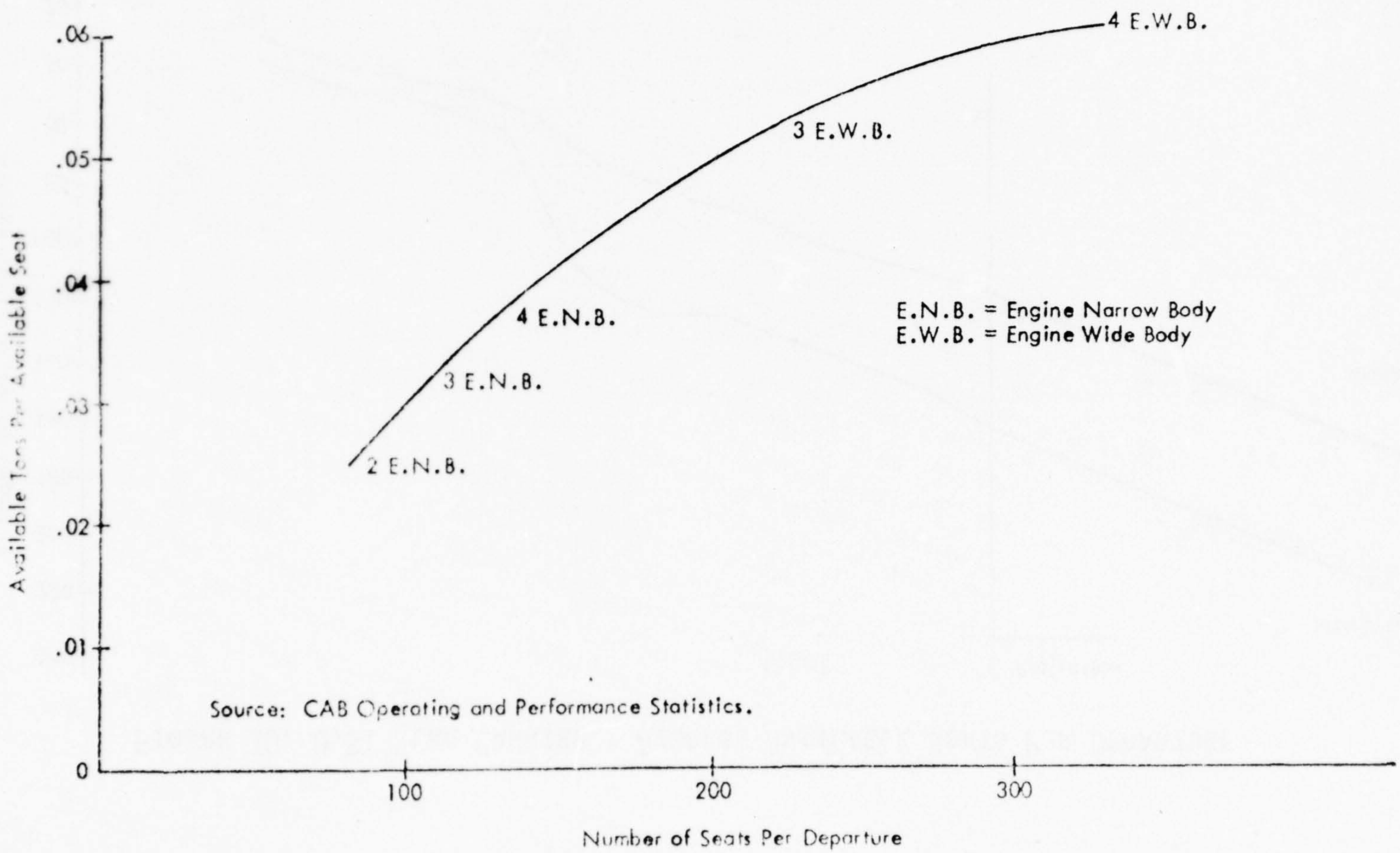
T5506

FIGURE 10. U.S. FLAG CARRIER - AVERAGE AVAILABLE SEATS PER DEPARTURE.



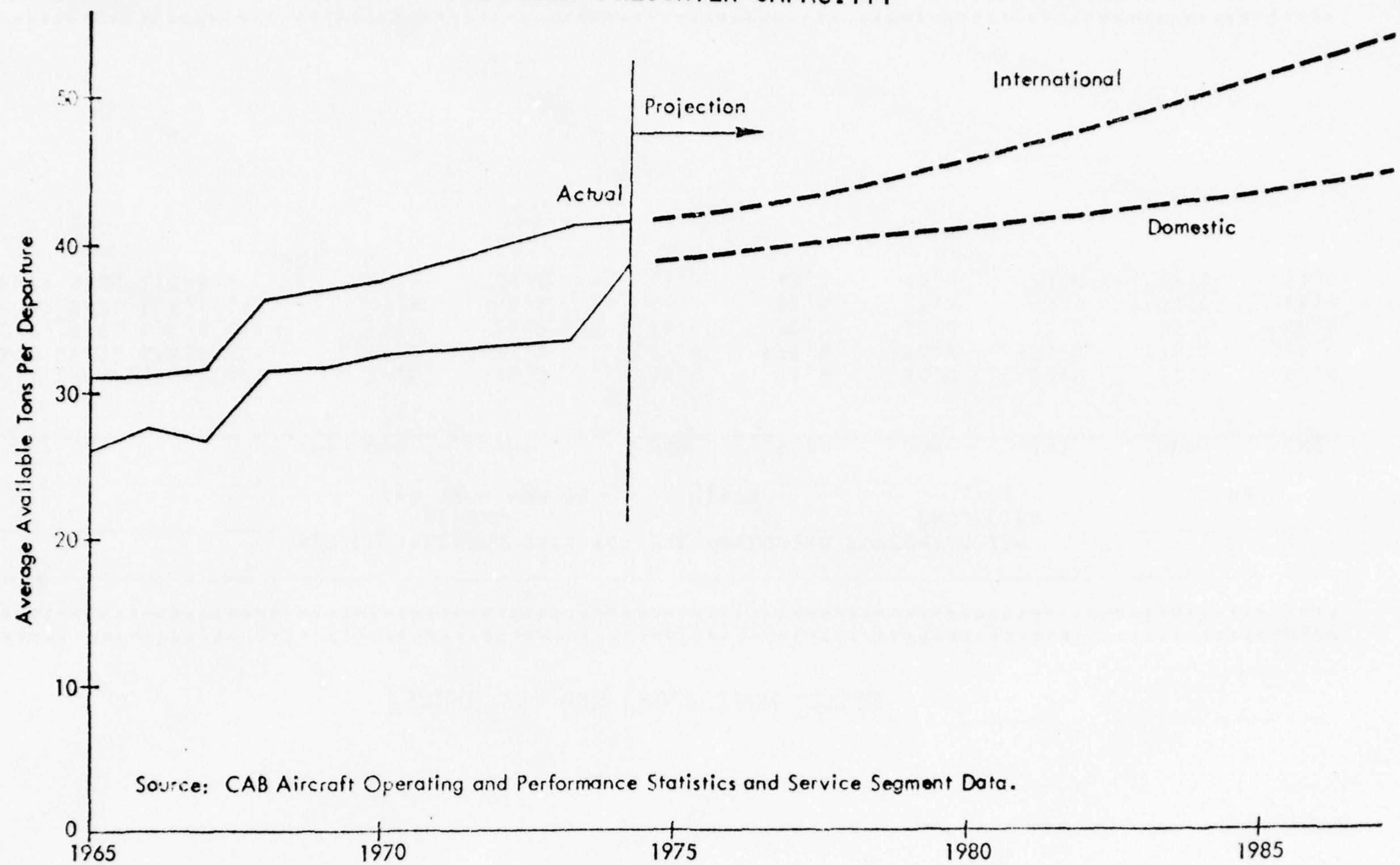
Source: Aircraft Operating and Performance Statistics.

FIGURE 11. DOMESTIC - PASSENGER AIRCRAFT LOWER HOLD CARGO CAPACITY.



Source: CAB Operating and Performance Statistics.

FIGURE 12. FREIGHTER CAPACITY.



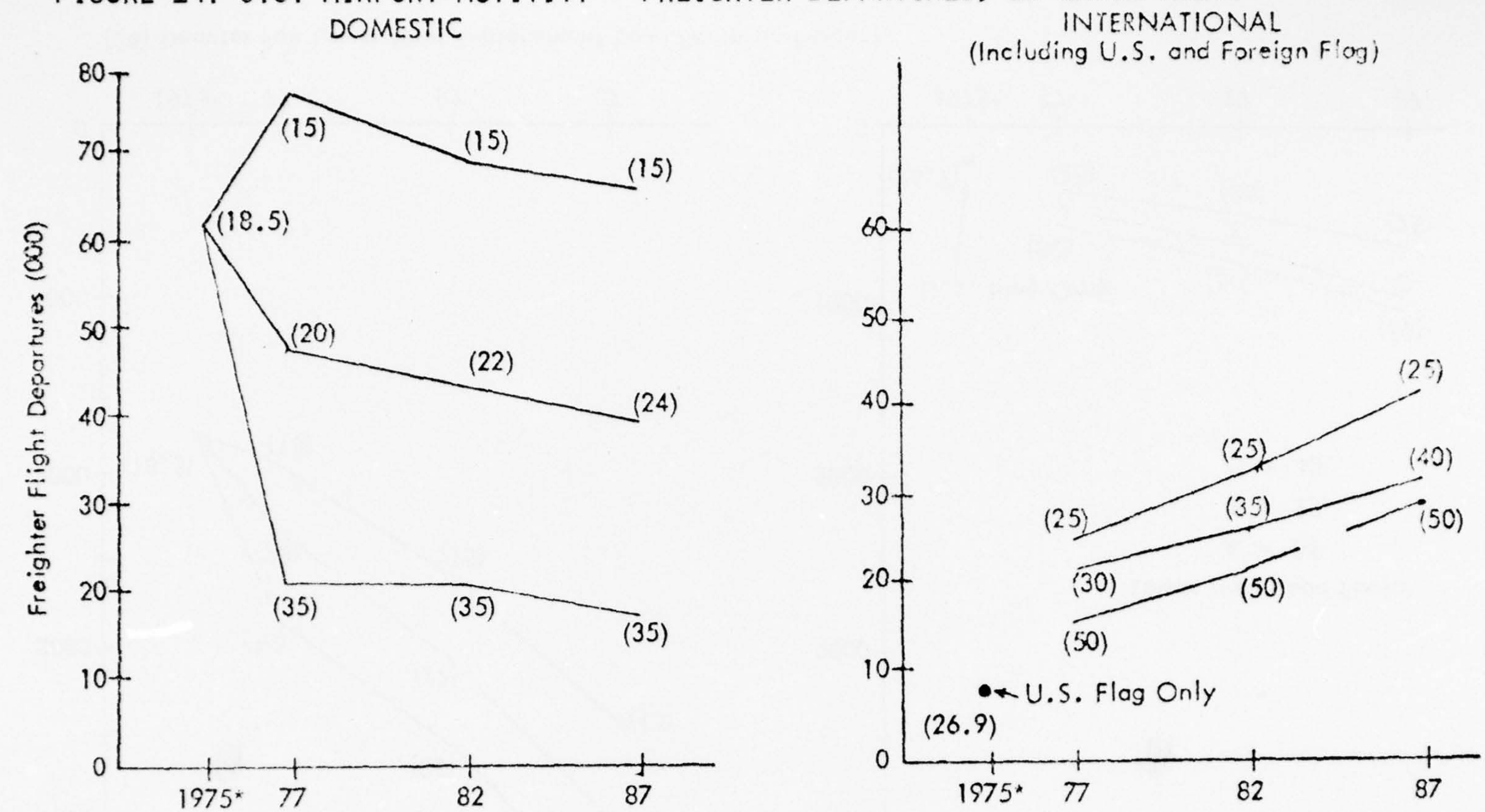
Source: CAB Aircraft Operating and Performance Statistics and Service Segment Data.

Figure 13. Hub Projection Tables

SYSTEM AVERAGES USED FOR THE FOLLOWING FORECASTS ARE

	ACTUAL APR 74 - MAR 75		PROJECTED 1977		1982		1987	
	DOM	INT	DOM	INT	DOM	INT	DOM	INT
PAX ENPL L.F.: (%)	47.6	46.2	48.0	46.0	50.0	50.0	52.0	52.0
AV. AVAIL SEATS/FLT:	118.2	163.4	130.0	175.0	150.0	195.0	170.0	215.0
L.M. ENPL L.F.: (%)	18.5	26.9	20.0	30.0	22.0	35.0	24.0	40.0
FRTR ENPL L.F.: (%)	41.6	58.6	44.0	61.0	48.0	63.0	52.0	65.0
FRTR SIZE (TONS):	38.5	41.8	40.0	43.0	42.0	48.0	45.0	54.0

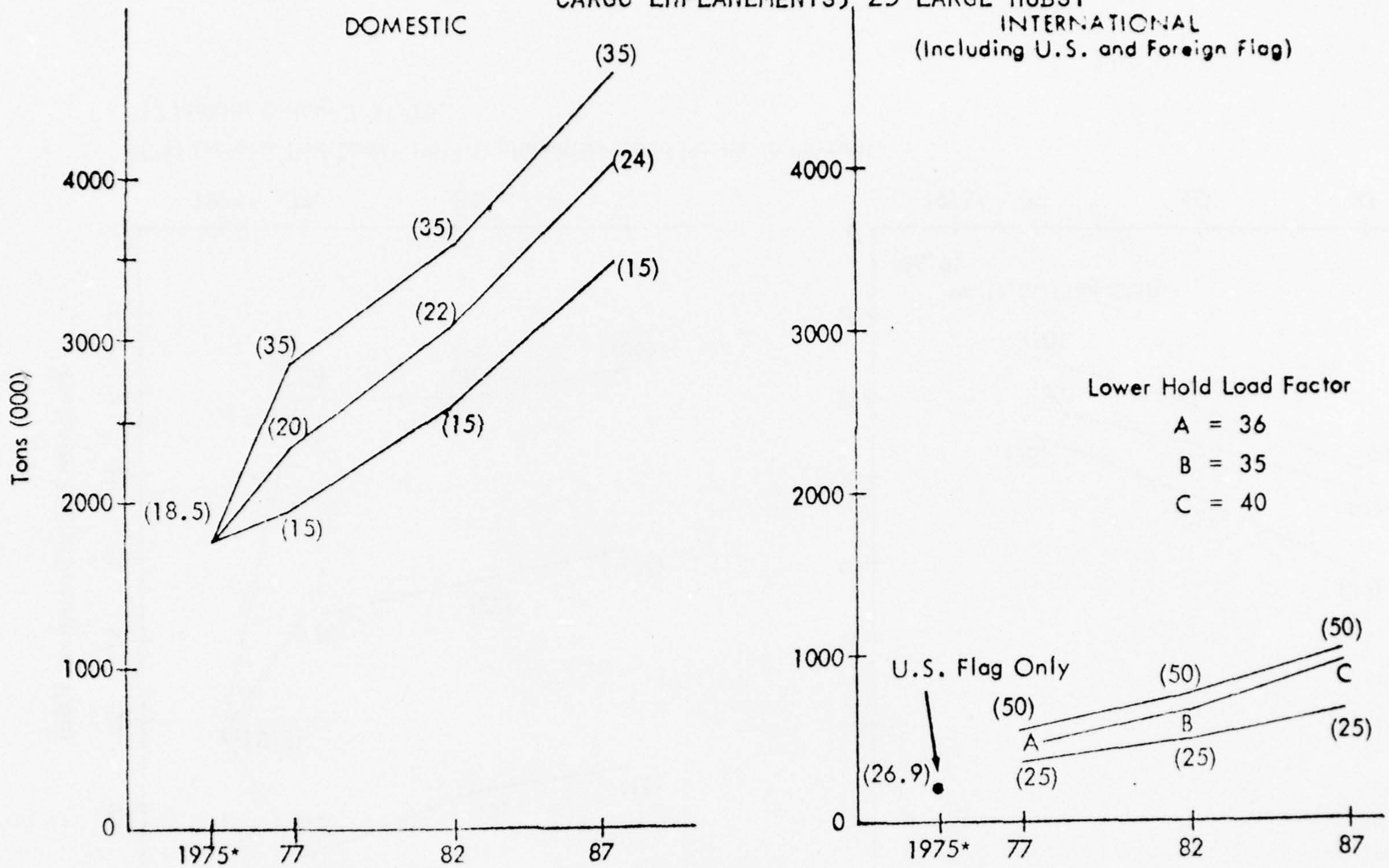
FIGURE 14. U.S. AIRPORT ACTIVITY - FREIGHTER DEPARTURES, 25 LARGE HUBS.



(24) Denotes Pax Lower Hold Enplanement Load Factor in Percent.

*12 Months Ending 3/31/75.

FIGURE 15. U.S. AIRPORT ACTIVITY - PAX LOWER HOLD CARGO ENPLANEMENTS, 25 LARGE HUBS.



(24) Denotes Pax Lower Hold Enplanement Load Factor in Percent.

ECONOMETRIC FORECASTING IN THE REAL WORLD OF AIRFREIGHT

- Thomas F. Sternfield
Market Research Analyst
The Flying Tiger Line

This afternoon I will be discussing some of the problems we at Flying Tigers have had with our own econometric forecasts and those of others, in attempting to effect planning, marketing, and operational decisions. In particular, I will be discussing the effects of non-stationarity (instability over time, which one is unable to predict) not only in the independent variables on which forecasts are based, but also in the coefficients which are purported to represent historical relationships between the dependent variable (airfreight revenue ton-miles) and the independent variables one chooses--in most cases, prices and yields.

Regardless of the time series chosen to represent the independent variables over which a regression equation is estimated (GNP, the ratio of potential GNP to actual GNP, airfreight yield, truck yield, the ratio of airfreight to truck yield, etc.), we at Flying Tigers feel that there is considerable evidence to suggest that the previous historical relationships between the dependent and independent variables may be significantly altered in the near future and especially in ten or fifteen years. This is again assuming that the equation variables adequately reflect the economic and behavioral phenomena that are contributing to the growth in airfreight activity. From your economics you may remember that the demand for any good is not only a function of prices and income but also the commodity itself, and here I am referring to the service characteristics involved in freight transportation. I have yet to see any time series, although we are trying to develop some, that could serve as proxies for the service characteristics of air and/or surface freight transportation. Thus, when forecasting, using econometric modeling techniques, one is constrained to the <u>ceteris paribus</u> assumption on the quality of freight transportation service. We feel that there are several things related to the political arena, economic uncertainty, and the way people make logistics decisions within their respective firms, that will be changing in the next few years.

Political Change and Airfreight Demand. There has been a lot of talk about deregulation of the airlines. Certainly there are several things that changes in regulation would do. You may have noticed that Federal Express is doing very well. I feel that one of the reasons for this is that they are the only deregulated operator in a closely regulated environment. If other airfreight carriers were to have unrestricted route authority, could pick up freight more than twenty-five miles from an airport, and could substitute truck for air over any linehaul segment, clearly the characteristics of the service shippers could obtain would be significantly altered.

Some of the less desirable things that could happen, but which are equally probable, are curfews and equipment modifications or replacement required by noise abatement regulations. Airfreight depends on late night departures and early morning arrivals in order to offer shippers and consignees next day service. With a curfew at an airport, it would be very difficult, if not impossible, for us, or anyone, to offer that service. Consider also equipment requirements. We keep hearing about retrofits that will be required for aircraft. We have some of the noisier aircraft in the commercial fleet (DC-8-63F's) and if equipment retrofit requirements are enacted, for which the necessary hardware has not yet even been developed, our operations would be severely hampered as well as our costs increased.

Not only does regulation affect airfreight, but it also affects competing modes of transportation. Consider the effects of speed limits and the possible breaking up of the Highway Trust Fund; these would significantly alter the historical trends over which the regression equations were estimated.

Equipment requirements also affect trucking. Table 1 is a linear regression that was estimated by Wade German from Pullman-Trailmobile and Professor Larry Peppers of Creighton University.1/ They attempted to forecast quarterly sales of heavy duty truck bodies using a sample period in quarters from 1956 to 1973. The regression equation plotted quite well for that time period as is evidenced by R-square of .96. The purpose of their article was to evaluate the quantitative impact on the demand for heavy duty trucks of the National Highway Traffic Safety Administration's imposition of Federal Motor Vehicle Safety Standard Number 121 (SS121). This required a "no wheel lock" air braking system for trucks and trailers, effective January 1, 1975.

1/ Wade H. German and Larry C. Peppers, "Social Control of Business: The Implications For Logistics Planning," in Interfaces: Logistics, Marketing and Production, ed. by Robert G. House and James F. Robeson. (Columbus, Ohio: Transportation and Logistics Research Fund, 1976), p. 23.

Just as there is clear evidence that the price hike on 1974 automobiles caused consumers to buy ahead in the summer of 1973, one would also expect that the trucking industry would attempt to "pre-buy" trucks with the anti-skid system prior to the deadline of January 1, 1975.2/ One would have expected this also since the trucking industry was opposed to the system.

Tables 2 and 3 illustrate the effect of SS121 on the demand for heavy duty trucks. The econometric model, which previously tracked very well, failed to account for this "pre-buy" effect. A prediction in 1974 for record sales in the trucking industry in 1975 would have seemed ridiculous during the midst of the oil embargo and the economic recession. Yet that is exactly what happened due to this "pre-buy" effect. Mr. Robert H. Shertz, Vice Chairman of the American Trucking Association, commented on the impact of SS121 on the trucking industry before the House Commerce Consumer Protection and Finance Subcommittee: "SS121 and its subsequent modifications have resulted in unbelievable instability in the trucking industry, costing millions of dollars."3/

Planning logistical analysis and econometrics can encompass orderly changes and can even deal with abnormal shocks when there is some knowledge of probable shifts in the planning parameters. But I don't think anyone would have expected an econometric model to account for this "pre-buy" effect.

Economic Changes and Airfreight Demand. The demand for airfreight is a derived demand for time-sensitive, high value commodities. We, at Flying Tigers, feel that there is considerable evidence to substantiate the fact that these commodities are growing such that they will represent a greater percentage of the market basket. Although you may accurately forecast the growth of the market portfolio and you calculate a coefficient (in the log-linear form an income elasticity), these elasticities may be biased downwards because of what we hope will be an increase in the rate of growth of high value weight commodities.

The Decentralization of Population and Manufacturing. We have experienced a recent growth of manufacturing employment in the South and Southwestern United States. Also many products are fabricated in the Orient and marketed in the eastern U.S. The movement of these goods, many of high technology and fashion items, are increasing the demand for airfreight.

2/ Ibid., p. 25.

3/ American Trucking Association, Inc., Truck Line (Washington, D.C.: No. 30, March 22, 1976), p. 1.

Growing Economic Uncertainty (especially the uncertainty in an inflationary economy of holding inventories). A shipper is constantly making cost tradeoffs by either holding a small amount of inventory in one place and using expedited transportation to move goods to his markets, or he has a warehouse echelon system with larger inventories and uses conventional transportation. This involves tradeoffs. Airfreight gives the shipper more flexibility in an uncertain economy, due to the radical reduction in lead time.

Changes in Logistics/Distribution Decision Making. We, and others, have been conducting research into the way people make transportation mode decisions and how they organize their logistics systems. Dr. Bernard La Londe, Professor of Marketing at Ohio State, created an 85 firm sample from the top 1000 manufacturing firms in the U.S. He questioned these firms as to how they made logistics decisions using a questionnaire with a five-point scale as shown in Table 4.4/ (The weighted average of the responses is shown below each question in Table 5.)

The propositions were submitted to the respondents five times over an 18 month period. The responses to his questions led Professor La Londe to conclude that "the corporate role of distribution has been enhanced in the typical U.S. firm as a result of the nature and scope of pressures put on the U.S. system" and that "a significant number of U.S. firms are considering permanent changes in distribution policies and procedures as a result of the uncertainties of the past two years."5/

Table 6 is developed from the doctoral dissertation of Dr. Douglas M. Lambert, an Assistant Professor at Michigan State University.6/ Dr. Lambert's research was concerned with how firms valued their inventories. Table 6 illustrates that there was a significant difference in what his research showed the firms he studied should be doing as far as calculating inventory carrying costs and what they were doing. The range of error was from 30 percent to 100 percent, in every case too low; thus, understating the advantages of inventory and carrying cost reduction that could be achieved through the use of airfreight. We feel that there will be opportunities for us to market airfreight on cost considerations when more firms take a closer look at their logistics system.

4/ Bernard J. La Londe, "Distribution Management in an Uncertain Economy," Distribution Worldwide, (April, 1976), pp. 42-46.

5/ Bernard J. La Londe, "Distribution Management in an Uncertain Economy," Distribution Worldwide, (April, 1976), pp. 42-46.

6/ Douglas M. Lambert, The Development of an Inventory Costing Methodology, (NCPDM Research Report, 1975), p. 113.

I would now like to make a few suggestions about airfreight forecasts. These are some of the things we're going to try. First, I would like to stress the need for understanding the causative relationships of the aforementioned factors and implementation of them into forecasting models whenever possible. I realize that the models produced thus far may represent the current State of the Art. If this is so, then we are going to have to do better. We need new yield variables. Sixty percent of our business comes from airfreight forwarders. Airfreight forwarders charge different prices than airlines. If one were to take airfreight revenues, subtract out payments to airlines from forwarders, add to that forwarder air transport revenues and divide by revenue ton-miles, you will have a more representative yield variable and a lower price elasticity. Using a time series of annual data for any forecast begs the question: are there substitutes for airfreight in the long run? If you take yearly data over a long enough period, you will find that everything is elastic. We feel that the substitution effect would be better accounted for with the use of quarterly data. Hopefully, a variable can be created to capture the effects of rising capital costs and their influence on inventory carrying costs. With the inclusion of this variable, the micro-economic decision process, through which a shipper goes when he is making an airfreight mode decision, could be modeled.

Also, I notice that the forecasts from the FAA were corrected for auto-correlation. When I am forecasting, I am not concerned with the effects of each independent variable. I am only interested in the general trend. But even though I can't explain the effect of each variable and I do have auto-correlation, I am better off, in most cases, using the serial correlated variables. Correcting for auto correlation by first differencing a time series, will bias coefficients downward and that may be the reason for the very conservative FAA forecast.

As I previously mentioned, we are just beginning work on modeling specific commodity flows. We see airfreight as a derived demand for activity in a specific sector of the economy. I don't like to stand up here and argue from a point of ignorance but perhaps next year we will have some of these things done and you can criticize me. I thank you.

TABLE 1

$$TRS = \underset{(-2.9)}{-33.3} + \underset{(26.1)}{.337}\ INF72 + \underset{(1.620)}{17.244}\ GNPGAP - \underset{(-2.688)}{0.719}\ PRL4$$

Interval 56:1 to 1973:3

$R^2 = 0.9557$
S.E. = 1.9817

TRS = Quarterly sales of heavy-duty trucks; seasonally adjusted; thousands of units.

INF72 = Business fixed investment; seasonally adjusted annual rates; billions of 1972 dollars.

GNPGAP = Ratio of potential to actual GNP; both measures in billions of 1972 dollars.

PRL4 = Prime interest rate, lagged four quarters; seasonally adjusted.

Source: Wade H. German and Larry C. Peppers, "Social Control of Business: The Implications For Logistics Planning," in Interfaces: Logistics, Marketing and Production, ed. by Robert G. House and James F. Robeson. (Columbus, Ohio: Transportation and Logistics Research Fund, 1976), p. 29.

TABLE 2

QUANTIFYING THE IMPACT OF SS 121

	(Truck Sales in 000's of Units) Actual Sales (Seasonally Adj.)	Forecasted Sales (Seasonally Adj.)	Forecast Residual (Forecasted Less Actual)
1973:4	49.1	43.7	- 5.4
1974:1	47.3	42.3	- 5.0
:2	46.4	39.7	- 6.7
:3	46.4	35.8	-10.6
:4	38.6	32.6	- 6.0
1975:1	30.5	30.1	- 0.4
:2	24.8	27.7	+ 2.9
:3	25.7	27.8	+ 2.1
:4	25.2	30.0	+ 4.8

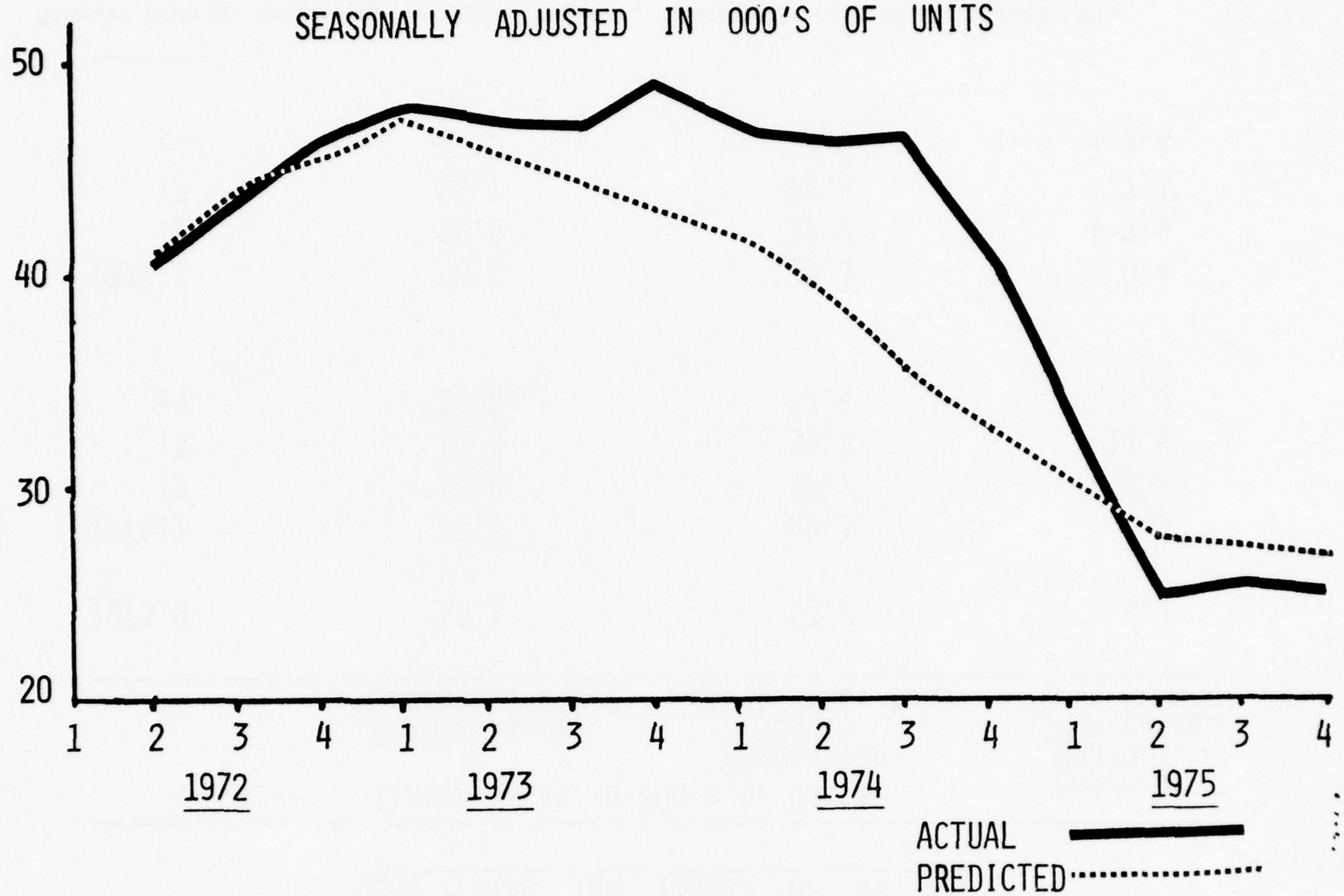
Source: Wade H. German and Larry C. Peppers, "Social Control of Business: The Implications For Logistics Planning," in Interfaces: Logistics, Marketing and Production, ed. by Robert G. House and James F. Robeson. (Columbus, Ohio: Transportation and Logistics Research Fund, 1976), p. 23.

TABLE 3

ACTUAL VS. PREDICTED

QUARTERLY SALES OF HEAVY-DUTY TRUCKS

SEASONALLY ADJUSTED IN 000'S OF UNITS



Source: Wade H. German and Larry C. Peppers, "Social Control of Business: The Implications For Logistics Planning," in Interfaces: Logistics, Marketing and Production, ed. by Robert G. House and James F. Robeson. (Columbus, Ohio: Transportation and Logistics Research Fund, 1976), p. 23.

TABLE 4

QUESTIONNAIRE EMPLOYED

FIVE POINT SCALE:

STRONGLY AGREE (+ 2)	AGREE (+ 1)	NO OPINION (0)	DISAGREE (- 1)	STRONGLY DISAGREE (- 2)

TABLE 5

	DATE OF QUESTIONNAIRE	WEIGHTED AVERAGE
THE CURRENT LEVEL OF ECONOMIC UNCERTAINTY IS FORCING OUR COMPANY TO RETHINK THE BASIC DESIGN OF OUR DISTRIBUTION SYSTEM.	7/75	.10
	4/75	.19
	12/74	.08
	8/74	.06
	2/74	.00
THE LEVEL OF INVENTORY INVESTMENT HAS BECOME A MORE CRITICAL MANAGEMENT PRIORITY DURING THE PAST YEAR IN MY COMPANY.	7/75	1.49
	4/75	1.70
	12/74	1.67
THE PRESSURES CREATED BY THE CURRENT ECONOMIC ENVIRONMENT WILL BRING ABOUT PERMANENT CHANGES IN DISTRIBUTION POLICIES AND PROCEDURES IN OUR FIRM.	7/75	.63
	4/75	.46
	12/74	.41
	8/74	.46
	2/74	.44

Source: Bernard J. La Londe, "Distribution Management in an Uncertain Economy," Distribution Worldwide, (April, 1976), pp. 42-46.

TABLE 6

	%/YEAR
INVENTORY CARRYING COST PERCENTAGE USED PRIOR TO THIS RESEARCH.	15.4%
INVENTORY CARRYING COST PERCENTAGE CALCULATED DURING THIS RESEARCH.	27.8%
ERROR	-12.4%

Source: Douglas M. Lambert, The Development of an Inventory Costing Methodology, (NCPDM Research Report, 1975), p. 113.

AIR CARRIER FORECASTS FOR HUB AREA AIRPORTS

- David W. Bluestone
Consultant
System Analysis Research Corporation (SARC)

OBJECTIVES

FAA is disaggregating and upgrading their forecasts of aviation activity. Our study disaggregates forecasts of passenger enplanements at the 24 major hubs served by 41 airports, to 1990, for all domestic scheduled certificated airlines. It then forecasts aircraft operations from enplanements.

Our hub forecasts were required to be consistent with FAA national forecasts of enplanements. We, therefore, distributed their aggregates by hub, but did not independently forecast the growth of total traffic.

OVERALL APPROACH

Our general approach is shown in the accompanying chart (see Figure 1). On the right, the FAA's total U.S. domestic passenger enplanements is controlling, and we estimated the share of the 24 hubs.

On the left, the distribution of hub enplanements was estimated on an econometric basis as described later. The relative distribution of enplanements by hub was then applied to the FAA levels to produce the forecasts. For multi-airport hubs, disaggregation by airport was then made.

To forecast operations from enplanements, we projected each airport's future seats per departure and boarding load factor.

DISAGGREGATION OF ENPLANEMENTS

A crucial contribution of this study is the disaggregation of enplanements into three classes. This is because number of passengers must be correlated with the economic power of the geographic locations which generate them, and not with the economic power of the places of enplanement where some of the ticket coupons are lifted, which are entirely different for two of the classes.

Generated passengers are those generated by the economy of each "base" hub itself. They are the tickets whose first coupon is lifted at the hub, including one ways, the going portions of round trips, and downline connections.

Returns on round trips are generated by stations where they are sold, and not at the hub where the return coupon is lifted.

Enplaning connections also depend on the generating power of the stations where they originate, but their volume is determined even more by airline scheduling practices.

All three types of enplanement are of major importance. For the 24 hubs as a whole, generated accounted for 44 percent, returns on round trips for 25 percent, and connections for 31 percent. There were, however, tremendous differences among individual hubs.

In order to disaggregate enplanements by type, we had to make a computer run from the original CAB O&D (Domestic Origin-Destination Survey of Airline Passenger) tapes.

GENERATED TRAFFIC -

CORRELATION WITH ECONOMIC CHARACTERISTICS

Our first correlations were between enplanements and various economic characteristics of all 24 hubs, using R^2 (coefficient of determination) for preliminary evaluation.

As expected, such factors as fares (as between different hubs, not over time), per capita income, and population, were not nearly as good as income (see Figure 2).

Econometric forecasting requires independent, authoritative, uniform forecasts of area economic data. One of the few such available is that of BEA (Bureau of Economic Analysis, Social and Economic Statistics Administration, U.S. Department of Commerce). Its forecasts include subclassifications of income earned by type of industry.

BEA also uses a top-down approach, from national totals, through relative industry growth rates, allocations to the 173 BEA economic areas in which it divides the country, population projections, to SMSAs (Standard Metropolitan Statistical Areas), and makes judgmental adjustments in rates of change and for internal consistency.

GENERATED TRAFFIC -

CLASSIFICATION OF HUBS BY ECONOMIC GROUP

Obviously, different hubs have different economic characteristics. One key we devised was the ratio of generated enplanements at the base hub to its total non-connecting enplanements, shown in the first column of the chart (see Figure 3).

Industrial cities generate at least half of their O&D traffic. Recreational hubs generate less than half, since they are primarily destinations of traffic generated elsewhere. Trade centers overlap both, with large outreach, 5 of the 6 generating at least half their traffic, and are also usually large connecting complexes.

Of course, all major hubs are mixtures of many kinds of economic activity, and any classification must be somewhat arbitrary.

GENERATED TRAFFIC -

CORRELATION WITH ECONOMIC CHARACTERISTICS

For each of the three hub classifications, we first tried regression analyses of generated enplanements with each of the seven major economic earnings classifications, and then in multiples.

Industrial hubs varied primarily with earnings from services (R^2 = .91) --about 3/4 of an enplanement generated per thousand dollars of services in 1958 dollars. This probably shows the multiplier effect of purchases of wage earners in manufacturing--generally considered about double their direct earnings.

Trade centers showed very high correlation (R^2 = .98) with both transportation--about 1 1/4 passengers per thousand dollars, and with construction--about 1 enplanement per thousand dollars.

Transportation includes the basic infra-structure of a hub--in order of importance, trucking and warehousing, communications, other transportation and services, utilities (electric, gas, sanitary, etc.), and railroads. Construction measures the speed with which a hub is physically growing.

Recreational hubs varied primarily with construction ($R^2 = .97$)--about 2.2 generated enplanements per thousand dollars, and a little with trade - 1/4 passenger per thousand dollars.

RETURNS ON ROUND TRIPS

This type of enplanement depends primarily upon the economies of the many stations other than the base hub. More precise economic data require more detail than was feasible within the resources of this project. We therefore, adopted a shorthand equivalency, by using the economies of only the five hubs ranking highest in the base hub's O&D, and the base hub itself.

Industrial hubs showed a .91 R^2 with its own construction and services, and with the construction and transportation of its five top markets (see Figure 4).

Trade centers showed a very high correlation of .97 with the total income of its own base BEA area, to be explained next under "connections."

Recreational hubs showed a very high correlation of over .95 with its own construction, and the transportation, and the transportation of its top five markets.

CONNECTIONS - CLASSIFICATION

We classified hubs by the relative importance of their connections. The major connecting hubs had over 38 percent of their enplanements in connections, and we termed them "connectors" (see Figure 5).

At the other extreme are those low in connections--less than about 20 percent, which are natural geographic terminations--"terminators."

Others are intermediate.

CONNECTIONS - CORRELATION

Connections are enormously complicated, depending on both generation by places other than the base hub, and by airline scheduling.

As a shortcut method for data analysis, we devised a new concept of "connecting BEA areas." This allocates the total income of all 173 BEA areas to major hubs in proportion to where its major airport's traffic connected, weighted by direction of connecting traffic flow.

Although this method leaves out of consideration the traffic connecting from other major hubs, which is considerable in some cases, the R^2s were each still over .98 (see Figure 6).

CORRELATION RESULTS

To test the reasonableness of our models, we compared our "forecasts" with actual in our base year 1974.

Actual figures are from enplanements, published in the *FAA/CAB Airport Activity Statistics*. O&D figures, used in our models, are typically lower, in 1974 averaging about 6 percent.

Our model's totals are the sum of our calculated generated traffic, returns, and connections. As compared to the average 6 percent understatement, our models showed an average deviation of about 6.5 percentage points, with half the hubs within 5 percentage points, and the least, 7/8ths, within 11 points.

ENPLANEMENTS AT MULTIPLE AIRPORT HUBS

At some airports, capacity to handle operations is a constraint on enplanements. In our study, we surveyed some of the limitations on various airports' current and future capacity. Airport capacity is a vastly complex study beyond the scope of our project, with many unsettled questions as to both measurement of capacity and how to increase it.

However, it was necessary to make assumptions about airport capacity at multiple airport hubs. We assumed that the 1974 level of operations would be the limit for the indefinite future. This assumption should be revised, of course, whenever specific figures can be substituted.

Using 1974 operations as fixed, we then applied to the lead airport a projected average seats per aircraft, and a boarding load factor, to calculate total enplanements.

For the other, or satellite airports at the hub, we assumed that they would continue to share in the non-lead airport enplanements in proportion to their 1974 ratios--again, an assumption to be revised whenever better data are available.

OPERATIONS BY AIRPORT

Operations were calculated by doubling departures, which were enplanements divided by the product of seats per aircraft and boarding load factor.

Seats per aircraft have been increasing for the airlines as a whole by a very smooth rate of 4.1 seats per year (see Figure 7). Converted to percentages, this rate was applied to each airport's 1974 seats per departure.

Boarding load factor (excluding through passengers) for the industry in 1974 was 47.1 percent. We assumed that the industry average will be 55 percent by 1980--the level established by the CAB for rate-making purposes, 57 percent by 1985, and 59 percent by 1990. Each airport's boarding load factor was assumed to increase in proportion to these industry increases, subject to a reasonable maximum and minimum at each airport.

MAJOR INNOVATIONS IN THIS STUDY

1. Disaggregate enplanements into three classes--generations, returns on round trips, and connections--so that enplanements can be made to correspond to the geographic locations responsible for their generation.

2. Disaggregate the best single indicator of traffic generations and round trips, personal income, into its major components of source of earnings by industry.

3. Analyze the complex problem of connections separately, grouping them by relative importance of their connections, and defining the economic areas from which they draw such traffic.

Much remains to be done in obtaining a better data base, refining their relationships, and monitoring forecasts against accumulating experience. We hope that this effort will help stimulate further developments in this important field influencing the investment of billions of dollars.

Figure 1

HUB AIRPORT FORECASTS

ENPLANEMENTS AND OPERATIONS

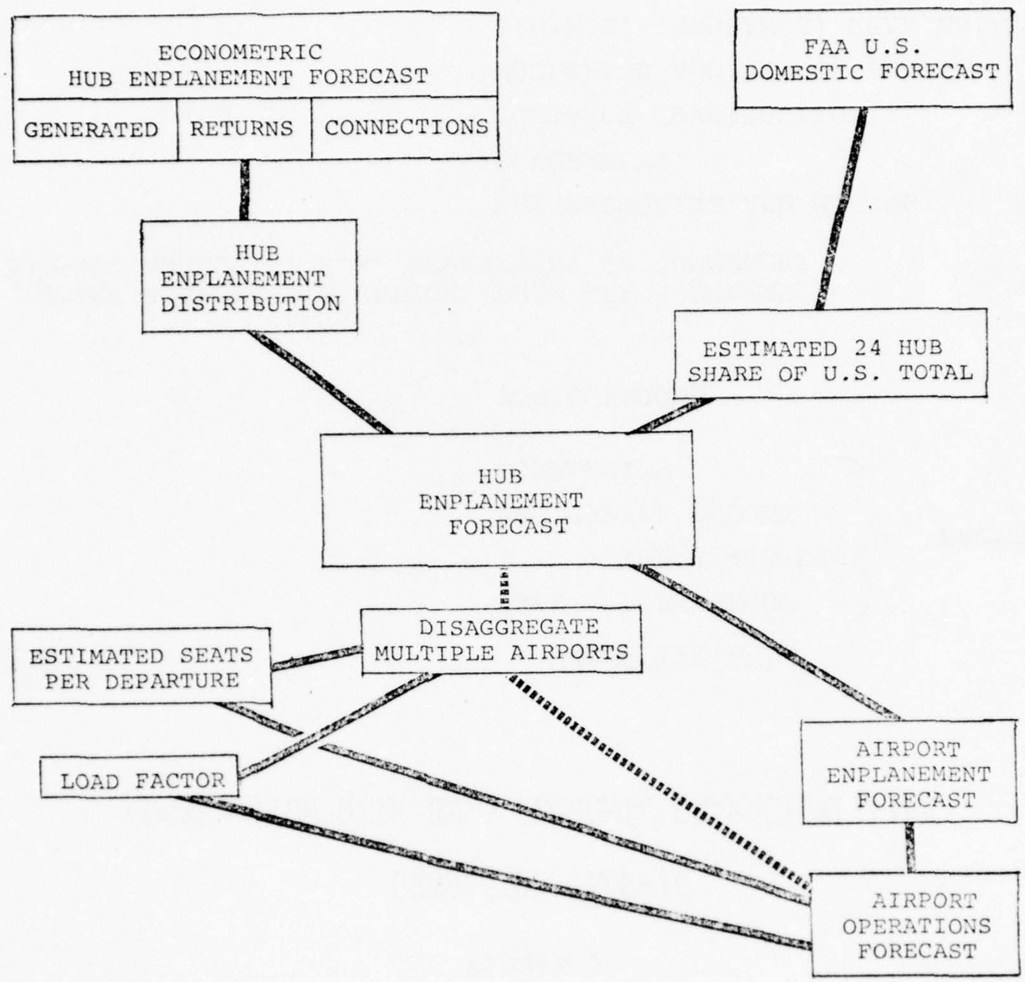


Figure 2

GENERATED TRAFFIC

CORRELATION WITH SMSA ECONOMIC CHARACTERISTICS

COEFFICIENT OF DETERMINATION (R^2)	CHARACTERISTIC	
.00126	FARE - TOP MARKET	FACTORS REQUIRED BY RFP
.02429	- TOP 5 MARKETS	
.52034	PER CAPITA INCOME	
.88747	POPULATION	
.93347	TOTAL INCOME	

WITH INCOME SUB-CLASSIFICATION (FROM BEA - BUREAU OF ECONOMIC ANALYSIS, U.S. DEPARTMENT OF COMMERCE)

.67037	MANUFACTURING AND MINING
.75393	GOVERNMENT
.84704	CONTRACT CONSTRUCTION
.92702	WHOLESALE AND RETAIL TRADE
.94018	FINANCE, INSURANCE, REAL ESTATE
.94829	SERVICES
.95998	TRANSPORTATION, COMMUNICATIONS, PUBLIC UTILITIES

Figure 3

GENERATED TRAFFIC

CLASSIFICATION OF HUBS BY ECONOMIC GROUP

BASE GENERATED ENPLANEMENTS AS PERCENT OF BASE TOTAL ENPLANEMENTS*	INDUSTRIAL	TRADE CENTERS	RECREATIONAL
60%	DETROIT		
59	CLEVELAND		
59	PHILADELPHIA		
57	PITTSBURGH		
57	MINNEAPOLIS		
55	ST. LOUIS		
55		NEW YORK	
54	BOSTON		
53	SEATTLE		
53		CHICAGO	
53		LOS ANGELES	
52	KANSAS CITY		
51	HOUSTON		
51		DALLAS	
50	MEMPHIS		
50		WASHINGTON/ BALTIMORE	
49			SAN FRANCISCO
48			DENVER
48		ATLANTA	
45			PHOENIX
39			NEW ORLEANS
38			TAMPA
28			MIAMI
19			LAS VEGAS

* EXCLUDING CONNECTIONS.

Figure 4

RETURNS ON ROUND TRIPS

CORRELATION WITH ECONOMIC CHARACTERISTICS, BY ECONOMIC GROUP

REGRESSION ANALYSIS WITH:

(1) INCOME OF BASE SMSA

(2) INCOME OF TOP 5 MARKET SMSAs

CORRECTED R^2	HUB GROUP	EQUATION
.90849	INDUSTRIALS:	-296,963 + .30059 X CONSTRUCTION + .10003 X SERVICES + .04391 X (CONSTRUCTION + TRANSPORTATION OF TOP 5 MARKET SMSAs)
.97167	TRADE CENTERS:	680,840 + .00985 X TOTAL INCOME OF BASE BEA AREA*
.95556	RECREATIONAL:	-188,399 + 1.70646 X CONSTRUCTION + .06017 X TRANSPORTATION OF TOP 5 MARKET AREAS

* SEE CONNECTIONS FOR DEFINITION

Figure 5

CONNECTIONS

CLASSIFICATION OF HUBS BY PERCENT CONNECTIONS AND GEOGRAPHIC STATUS

PERCENT, CONNECTIONS OF ENPLANEMENTS	CONNECTOR	INTERMEDIATE	TERMINATOR
72.7%	ATLANTA		
54.9	DALLAS		
46.6	CHICAGO		
46.0	DENVER		
45.6	MEMPHIS		
41.3	PITTSBURGH		
38.1	ST. LOUIS		
27.5		KANSAS CITY	
25.6		MINNEAPOLIS	
25.4		CLEVELAND	
24.3		NEW ORLEANS	
20.3		LOS ANGELES	
20.2			SEATTLE
20.0		WASHINGTON/ BALTIMORE	
19.3		SAN FRANCISCO	
18.1		LAS VEGAS	
17.6			TAMPA
17.5		HOUSTON	
17.1			PHOENIX
15.4		DETROIT	
15.1			PHILADELPHIA
9.8		BOSTON	
5.7			NEW YORK
4.1			MIAMI

Figure 6

CONNECTIONS

CORRELATION WITH TOTAL INCOME OF CONNECTING BEA AREAS*

CORRECTED R^2	HUB GROUP	EQUATION
.98695	CONNECTOR:	600,241 + .00961 X CONNECTING BEA AREAS INCOME
.99169	INTERMEDIATE:	334,793 + .00874 X CONNECTING BEA AREAS INCOME
.98120	TERMINATOR:	224,668 + .04768 X CONNECTING BEA AREAS INCOME

* Connecting BEA Areas = BEA Areas With Five Or More Percent Connections Through Specified Hub. Income Assigned Proportionate To Connections.

Figure 7

OPERATIONS BY AIRPORT

SEATS PER AIRCRAFT

INDUSTRY GROWTH: 4.1 SEATS PER YEAR, CONVERTED TO PERCENTAGES

INDIVIDUAL AIRPORT GROWTH: BASE OF 1974 COMPUTED SEATS PER DEPARTURE*
+ ANNUAL INCREASE OF INDUSTRY GROWTH RATE

BOARDING LOAD FACTOR (EXCLUDES THROUGH PASSENGERS)

1974: ACTUAL* 47.1%

1980: INDUSTRY AVERAGE 55.0%
EACH AIRPORT LOAD FACTOR INCREASED OVER 1974 ACTUAL BY 55.0%/47.1%
MAXIMUM: 60%
MINIMUM: 45%

1985: INDUSTRY AVERAGE 57.0%
EACH AIRPORT LOAD FACTOR INCREASED OVER 1980 BY 57.0%/55.0%
MAXIMUM: 65.0%
MINIMUM: 50.0%

1990: INDUSTRY AVERAGE 59.0%
EACH LOAD FACTOR INCREASED OVER 1985 BY 59.0%/57.0%
MAXIMUM: 65.0%
MINIMUM: 52.5%

OPERATIONS = ENPLANEMENTS/SEATS PER AIRCRAFT X BOARDING LOAD FACTOR

* Developed from Airport Activity Statistics.

MAJOR HUB FORECASTS

- Charlotte Chamberlain
Economist
Transportation Systems Center (TSC)

For some time, it has been a goal of FAA to provide disaggregate air activity forecasts at the Major Hubs. The first installment of this ongoing project was completed in FY 76. The forecasts extend annually to 1990 and cover:

Enplanements and Operations

U.S. Flag Domestic Certificated Air Carriers
U.S. Flag International Certificated Air Carriers
Intrastate
Commuter

Cargo and Mail
Enplaned Tonnage and Operations

U.S. Carriers Lower Hold
Foreign Flag Lower Hold
Freighters

General Aviation

Local
Itinerant

Three separate groups produced the components of the forecasts. Systems Analysis and Research Corporation (SARC) produced enplanements and operations forecasts for the Domestic Certificated Air Carriers. TSC produced the remainder of the passenger activity forecasts and cargo exclusive of mail. Optimum Computer Systems produced the GA forecasts. This report will cover the special passenger activity forecasts as all other components are covered elsewhere.

TSC forecast commuter, intrastate, U.S. flag international and foreign flag activity. An arbitary cut-off of 100 flights per week according to the OAG, June 1975, was used so as to sort out which kinds of activity would be forecast at each airport. Figure 1 shows the types of special passenger activity forecast at each hub.

It was judged that international traffic in the future will tend to be generated directly from non-hub airports. Hence, special efforts were made to forecast international traffic at airports with currently less than 100 such flights per week. For 1972 through 1975 data were culled from the ER 586 tapes for aggregate U.S. international enplanements and operations. For each airport for which international data were not directly collected, U.S. flag international enplanements and operations were recorded from the ER 586 data for 1975. Ratios were compiled as to each airport's share of enplanements and operations. A U.S. Aggregate Model was estimated and forecast and the 1975 ratios applied to the aggregate operations and enplanements forecasts to derive the necessary individual airport forecasts.

In general the data for fares came directly from the OAG. Income and population data are derived from OBERS, Volume 1.

FAA is preparing twenty-four reports covering each of the selected hubs. Each report will include a descriptive airport profile covering:

- Location
- Operator
- Area Served
- Regional Economic Outlook
- Air Traffic Components
- Forecast Summary of Passenger Activity
- Airport Capacity Constraints

Tables of forecasts for each component of air activity followed by graphical representations of the forecasts and estimated models will comprise each report. A prototype of the Detroit Hub material is presented below.

PROTOTYPE MAJOR HUB FORECAST

DETROIT METROPOLITAN WAYNE COUNTY AIRPORT (DTW)

Location

Metropolitan Wayne County Airport is located 23 miles southwest of the center of Detroit.

Operator

The Wayne County Road Commission.

Area Served

DTW serves the local traffic generating area comprised primarily of southeastern Michigan and the metropolitan area of Windsor, Ontario. Detroit's domestic connecting traffic area covers all of Michigan and the northern portion of Wisconsin where it overlaps the service area of Chicago. International traffic is drawn from the local trade area.

Types of Traffic

Air traffic at Detroit is heavily dependent upon the automobile industry. However, Detroit is more than an automobile city with industry in basic steel, pharmaceuticals, business and machine instruments, machine tools, and paints and heavy chemicals. Detroit is also a major port with access to the sea through the Great Lakes.

Detroit ranks high as a generator of traffic with 61 percent of enplanements generated from the local economy, 24 percent returning to their point of origin and only 15 percent connecting from other domestic flights.

Since 1969, Detroit has produced very little growth in enplanements with an annual rate of 0.8 percent. On a short term basis, high unemployment in the Detroit area seems to mean increased air travel as a result of the high unemployment benefits received by automobile workers.

International service at Detroit has been very erratic. At various times the city has had direct service to Europe, Bermuda, the Bahamas, and other points in the Caribbean; most of which is terminated at the present time. It can be expected that efforts to relieve congestion at gateway airports such as New York and Los Angeles by direct routing from internal cities will stimulate future international traffic at Detroit. Figure 2 depicts our forecast for international traffic at Detroit metropolitan.

FIGURE 1

Commuter airlines are fairly active at Detroit but are a very minor portion of air traffic.

All types of aircraft operate at Metropolitan Wayne County, ranging from twin engine turbo-prop to three and four engine wide-bodied jets.

The top five domestic air markets paired with Detroit are compared in rank order: New York, Chicago, Los Angeles, Washington, and Miami.

Forecast

While domestic travel is expected to expand slowly at Detroit, international travel is expected to grow rapidly at 6.87 percent per year.

Figures 3 and 4 show forecasts for Detroit's primary and reliever airports. In recent years economic growth at Detroit has been sluggish and population growth has been negative. These trends are not expected to continue in the future with the result that both enplanements and operations will grow at rates near the national averages. In the forecast period through 1990 domestic passengers will increase 166 percent, at an annual rate of 6.3 percent while operations will increase 39 percent at an annual rate of 2.1 percent.

Commuter traffic is expected to continue to be an insignificant portion of Detroit operations.

Total operations at Metropolitan Wayne County Airport will increase from 145,026 in 1974 to 206,335 in 1990 at an average annual rate of 2.23 percent.

Airport Limitations and Major Plans

The FAA estimates that Metropolitan Wayne County has an operating capacity of 340,000 operations per year and a potential capacity of 425,000 operations. The forecast indicates that the latter level will not be reached before 1990.

At present Detroit is a Class II terminal control area with one fully instrumented runway. Delays of four minutes are encountered only during bad weather and at peak arrival and departure times.

Present plans call for construction of a 10,000 ft. runway to provide two sets of parallel runways. Plans to provide a second ILS runway are currently being held up by a court injunction.

FIGURE 2

FIGURE 1

MAJOR HUB FORECASTS
COMMUTER, INTRASTATE AND INTERNATIONAL

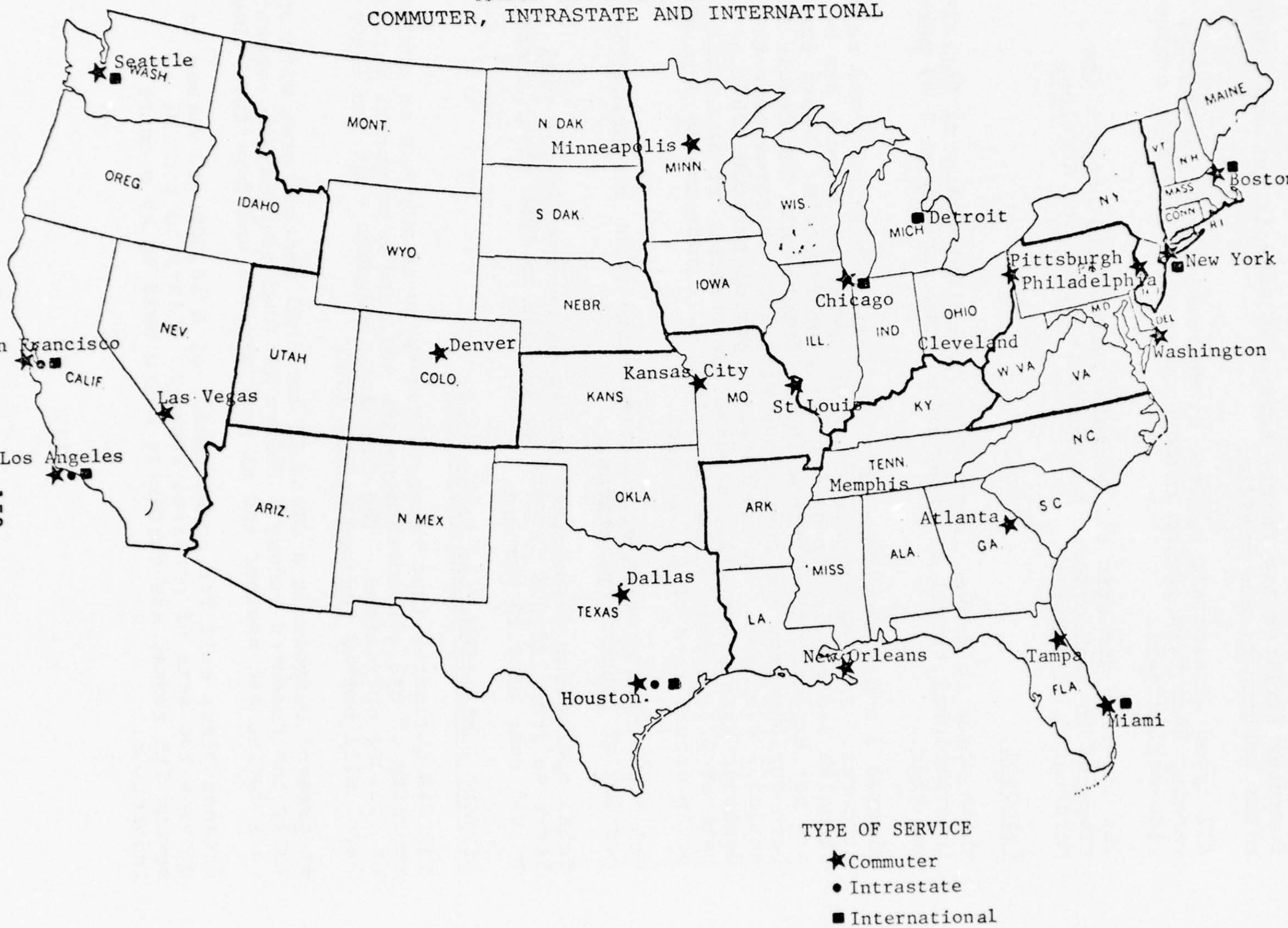
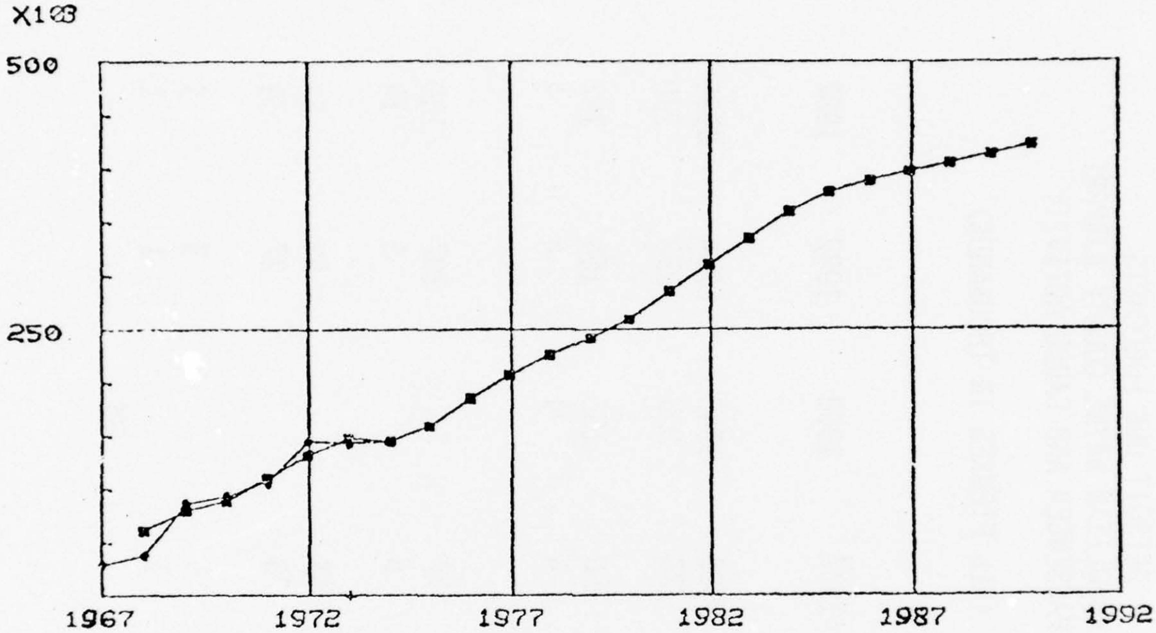


FIGURE 2

DETROIT METROPOLITAN

FORECAST OF U.S. FLAG INTERNATIONAL ENPLANEMENTS



TIME BOUNDS: 1967 TO 1990

SYMBOL SCALE NAME

- ■ FORECAST VALUES
- ● HISTORICAL VALUES

FIGURE 3

DETROIT HUB FORECASTS
METROPOLITAN WAYNE COUNTY AIRPORT
PASSENGER AND CARGO ACTIVITY

(ALL FIGURES IN THOUSANDS)

	1977	1980	1982	1987	1990
ENPLANEMENTS					
CAC DOMESTIC	4509	5540	6234	8385	9793
CAC INTERNATIONAL	173	208	230	279	307
OPERATIONS					
CAC DOMESTIC	150	156	164	187	201
CAC INTERNATIONAL	4	4	4	4	4
CARGO (INCLUDES MAIL)					
LOWER HOLD (TONS)					
DOMESTIC	77		107	140	
INTERNATIONAL	5		9	14	
FREIGHTER (TONS)					
DOMESTIC	53		54	64	
INTERNATIONAL	20		27	39	
FREIGHTER OPS					
DOMESTIC	3		3	3	
INTERNATIONAL	1		1	1	
GA ITINERANT		83			85

FIGURE 4

DETROIT HUB FORECASTS
RELIEVER AIRPORTS

(ALL FIGURES IN THOUSANDS)

AIRPORT	1977	1980	1982	1987	1990
DETROIT CITY					
CAC ENPLANEMENTS	36	43	48	65	76
CAC OPERATIONS	3	3	3	4	4
GA LOCAL		85			100
GA ITINERANT		130			130
WILLOW RUN					
GA LOCAL		110			120
GA ITINERANT		79			93
ANN ARBOR MUNICIPAL					
GA LOCAL		80			100
GA ITINERANT		50			60
PONTIAC-OAKLAND					
GA LOCAL		169			274
GA ITINERANT		138			192

A MACRO-MICRO FORECAST PACKAGE

- Cecil O. Brown
Manager, Long Range Forecasting
Délta Airlines

Only a few years ago, it was virtually impossible to discuss forecasting with other people in the business because inevitably while all might agree on rates of growth, different forecasters starting from different bases produced different forecast values. There was an almost complete lack of standardization in data which resulted in severe problems in communication.

It was apparent to all operating under these conditions that a serious need existed to develop a standardized system of forecasting. This sytem would consist of a structured basis of historical data, macro forecasts of the industry as a whole developed by consensus of the participants within that industry, and micro forecasts of parts of the industry as appropriate and needed.

Because of the problems of communication and the need for standardization, there gradually evolved a forecasting philosophy within the Air Transport Association which in essence divided forecasting into three time periods:

a. Short range forecasting which involved a time period of 1-2 years and included whatever cyclical variations were appropriate and foreseeable.

b. Intermediate range forecasts covering periods of 5-7 years which may or may not include cyclical variations, depending on the personal bravery of the forecaster.

c. Long range forecasts covering periods to 25 years or longer which were smoothed line forecasts around which cyclical variations would occur but in which no such variations were forecast.

Because of experience in the past with so-called "analysts" who reacted to the lack of cycles in the long range forecasts, this philosophy developed a further refinement in that forecasts are put together using as a base year the latest known actual data available, skipping over the intermediate and short range forecasts and starting the long range smoothed forecasts at a point beyond the intermediate.

Within the framework of the above philsophy, a need for a quadripartite package of macro forecasts was seen. The first of these forecasts, the Domestic Passenger Forecast, was published in June, 1975. An evaluation which may result in an update of this forecast is scheduled in June, 1977.

The second part, the International Passenger Forecast, published in April, 1976, showed growth rates of U.S. Flag and U.S. Connected Foreign Flag Carriers in international operations.

The third part of this package, the Domestic and International Cargo Forecast, is scheduled to be published approximately June, 1977, and is currently in the process of development.

A fourth part of the package, called the Macro-Micro Forecast or Macro-Micro Matrix, is the next major project after completion of the Domestic and International Cargo Forecast. It is based on the concept that 64-66 hubs represent approximately 87 percent of total enplanements in domestic operations in the United States. Essentially, the project proposes to develop a matrix of the percent participation of this group of hubs to the total industry. As a parallel to this, though we do not propose to develop a similar thing on cargo, it is interesting to note that 50 hubs compose 97 percent of the cargo enplaned tons in the United States. The thesis of our approach to the project is that if we can keep the relationship of the major and intermediate hubs in proper perspective, the sum of the parts will continue to equal the whole and the world will stay in balance.

The purpose of these forecasts as used by member airlines of the Air Transport Association is for fleet planning, personnel planning, marketing planning, and financial planning. They become, in short, the guideline forecast documents around which all other detailed planning activities take place. This is not to infer that they are slavishly followed regardless of the purpose of the detailed forecast but serve as a base line against which these specific purpose forecasts can be compared. A sales forecast would not be the same as a forecast whose purpose was fleet planning. The former should lean toward optimism, and the latter would undoubtedly be a more conservative approach. Both should be related to the base line operational forecast from which they derive. The Domestic Industry Passenger Forecast mentioned previously was recently used by the Air Transport Association as a key document in analyzing and predicting the scope of a major problem within our industry.

These are not intended to be one shot forecasts that are put on the shelf and forgotten but are used daily by those of us participating in micro forecasting within the industry and are intended to be monitored and maintained on at least an annual review basis.

Using these macro forecasts, then, as controlling documents, the hub forecasts are developed. Since the primary technique used within the Air Transport Association is the top-down approach to hub forecasting, the first element to be forecast is the percent of the macro industry contained in any one hub, or theoretically put, that no hub exists as an entity but only as a part of the total complex interrelated industry.

The top-down methodology used in the Air Transport Association is cross checked by the bottom-up approach. A series of mini forecasts of city pair performance within the particular hub being forecast as a base is made and summed to check against the top-down forecast created initially. The same basic philosophy is applied to hub forecasting as in the macro forecasts cited above, that is, we use a short, intermediate, and long range forecasting approach.

Within the concept of hub forecasts, there are two separate approaches taken depending on the degree of complexity or the size of the hub basically to be forecast. The large hubs which have multi-airport service or that are approaching a size that would make multi-airport service necessary are forecast by using a dual approach.

The first part of this approach is the creation of an unconstrained hub forecast without consideration as to whether or not existing or planned airport facilities would have the capability of handling the traffic forecast.

The second part is the final hub forecast developed after the Properties and Facilities people in the airlines concerned have defined the limits of airport capability to handle this traffic.

Thus, really, three steps are taken. An unconstrained approach, an analysis of that traffic in regard to existing facilities, and a decision whether or not facilities must be constructed is followed by a three-part consideration of the final forecast.

These hub forecasts are used primarily in providing information for the development of facilities at airports such as baggage handling, passenger handling, freight facilities, runways, taxiways, and access roads that are used as a basic input to the Master Planning process.

Their primary thrust is to develop an analysis of the activity within the design hour which for our purposes in the Air Transport Association is the Peak Hour of the Average Day of the Peak Month. Using the data created for this hour, the aircraft size mix and passenger activity taking place within that period of time are determined.

Since the macro and micro forecasts are an interrelated packgage as can be seen from the foregoing discussion, it follows logically that a macro-micro matrix relationship development would be an invaluable tool as a quick reference doucment for relative airport size and growth relationships.

The concept of this matrix is based on the need to keep the entire whole at 100 percent so that the sum of hubs does not equal more than the total industry. The matrix is not intended to be used as a forecast. It is intended as a reference document for providing relative forecast growth over the same period of time as the previous forecast discussed.

It is obvious that as individual hub forecasts are put together and added to the total package of development the matrix has to change; and, it is this changing process involved in the dynamics of the industry which requires the whole interrelated complex of forecasts.

These forecasts and/or the advice or assistance where needed of the members of the forecasting staff of the Air Transport Association and member airlines are available to contract personnel working on various master plan projects and others who are forced to operate in the "Never-Never Land" of predicting the future.

QUICK-RESPONSE COMPUTER ANALYSES FOR TOWER AIRPORT OPERATIONS

- Ronald H. Hobbs
Vice President and Senior Systems Consultant
Advanced Technology, Incorporated

The purpose of this presentation is to identify a capability within the FAA to provide aircraft operations statistics at tower airports as far back as January 1972. The basis of this capability is a set of interactive computer programs on a time-share system that performs retrieval and analysis of airport operations data in a quick-response mode. The system is operable by non-computer or statistically-oriented users, and provides tabular as well as graphical outputs. The retrieval options provide a capability to examine statistics for:

- Any number of airports
- Any type of operation
- Any selected period of time

Figure 1 is an example of FAA form 7230-1, which is the source of the data for the quick-response (Q-R) programs. As can be seen, data are available for four (4) types of itinerant operations (Air Carrier, Air Taxi, General Aviation, and Military), and for two (2) types of local operations (General Aviation and Military). These six, and any combination thereof, can be selected for analysis with the Q-R programs.

Figure 2 shows the FAA tower airport population and identifies the tower airports that have been commissioned (and decommissioned) from January 1972 to March 1976. In addition to these airports, the initial base of airports is represented by 347 airports operational prior to January 1972. The current calendar year (CY) and fiscal year (FY) data bases for the (Q-R) programs include only those airports that were operational throughout a complete year. Although the data for the first partial calendar year of operation of any airport are not currently included in the Q-R data base, they have been processed and will be available in an updated version of the Q-R data base to be available in February 1977. These data are represented by the shaded areas on the chart. [Through December of 1975, they represent a total of 381 months of data from 67 airports and nearly 5 million operations (17 mos in CY72, 140 mos in CY73, 79 mos in CY74, and 145 mos in CY75.]

The status of the current Q-R data base is indicated in Figure 3. It includes seven (7) Q-R files representing:

(1)	347 airports for CY72	(5)	388 airports for CY74
(2)	346 airports for FY73	(6)	387 airports for FY75
(3)	353 airports for CY73	(7)	403 airports for CY75
(4)	351 airports for FY74		

Four (4) Tower Airport Statistics Handbooks have been published for the Calendar Years 1972 through 1975. The statistics generated within the handbooks were a direct application of the Q-R programs and their options. Currently use of the Q-R programs is limited to selecting one of the seven (7) data bases for analyzing operations over a one-year period. By February or March of 1977, the data base will be expanded to include 403 airports for FY76 and 421 airports for CY76. More importantly, the partial year data identified in the previous slide will be included, and a continuous daily data base of 432 tower airports (commissioned and operational as of December 1976) will be developed so that the Q-R analysis will be operable over any selected time period from one day to five years. Additionally, after January 1977, the data base will be kept current and updated on a monthly basis. This will provide capability for a near real-time analysis of operations.

There are six (6) basic outputs from the Q-R program (see Figure 4):

- Table 1 provides statistics on an airport basis, and an example will be shown on the next chart.
- Table 2 is the same as Table 1, but statistics are based upon an average airport from a selected group of airports.
- Table 3 provides means and standard deviations for daily operations on Sunday, Monday, ..., Saturday for a single airport or the average from a selected group of airports.
- Table 4 produces graphical histograms and associated tabular data describing a frequency distribution of airports as a function of daily, weekend, weekly, monthly, quarterly, or annual operations.

- Table 5 provides a graphical description (and associated tabular data) of operations on a week-to-week, month-to-month, or quarter-to-quarter basis over any selected time period. This output provides a trend analysis on any individual airport or the average for a selected group of airports. An example of this output is presented in a subsequent chart.

- Table 6 is the only output not available in the published handbooks. It is a graphical output (with associated tabular data) that related peak operations (1st and 2nd peaks only) to the average operations for any selected group of airports. An example of this output is presented in a subsequent chart.

Figure 5 is an example of a Table 1 (Single Airport Activity Statistics) for the Dulles International Airport during CY75. It displays 14 statistics (daily, peaks, weekly, monthly, quarterly, and annual) for nine (9) types of operations. A Table 1 for each operational airport forms the bulk of The Tower Airport Statistics Handbook published each year by the FAA. The Q-R programs provide this output and optionally allow for any subset of the 14 statistics versus any subset of eleven (11) types of operations.

The raw (daily) data base that develops this output was recently used to provide 50th percentile and 90th percentile total operations for the 403 airports operational during CY75. This request came from the Civil Service Commission to perform a wage/rate analysis for air traffic controllers.

Figure 6 is the tabular output for Table 5. This example comes from a request by the Transportation Systems Center (TSC) to obtain GA monthly operations data over CY74 and CY75 in order to develop a model to forecast monthly GA itinerant and local operations for two years in the future. The average operations in the GA column of Table 5 were simply multiplied by the number of airports (403) to obtain the desired data for each month.

Figure 7 shows the optional graphical output of Table 5. It presents the annual distribution of airport activity for average itinerant operations for all 403 airports operational during CY75. It shows the trend of average monthly operations over the year and could also be used to validate CY75 forecasts of previous years.

Figure 8 is an example of the Table 6 output which provides a peak-to-average activity analysis for weekly, monthly, or quarterly operations. This example shows the relationship of 1st and 2nd monthly peaks to average total monthly operations for the seven (7) tower airports in Virginia operational during CY75. The output also identifies the airport at which the peak operations occurred.

Figure 9 is the optional graphical output of Table 6. The airports could have been selected to represent a hub or particular "type" of airport in order to identify peak-to-average statistics on a continuous basis like the single statistics available in the Table 1 output. This could form the basis for applying forecasting models of peak activity to new or similar airports.

Summary

These Q-R programs and the associated data bases for Tower Airport Statistics have had only limited use during the development stages that were initiated by the FAA in early 1974. At that time the data bases were available on the system 18 to 30 months after the fact. The Q-R programs provide any member of the aviation community, anywhere in the United States, a capability to perform historical, current, and forecasting analysis on a quick-response basis. The execution of the programs are based on simple multiple-choice options requiring no computer or statistical background, and the user must simply have access to the system and a time-share terminal.

FIGURE 1

RIS: AT 7230-99

AIRPORT TRAFFIC RECORD	MONTH AND YEAR August 1973

INSTRUCTIONS–*File original in facility file; Send copy to Washington Office, EC–200.*

AIRPORT	IDENT.	LOCATION
Tweed/New Haven	HVN	New Haven, Conn.

AIRPORT OPERATIONS COUNT

DATE	ITINERANT					LOCAL			TOTAL OPERATIONS (I)	SPECIAL USE (J)
	AC (A)	AT (B)	GA (C)	MI (D)	TOTAL ITINERANT (E)	CIVIL (F)	MILITARY (G)	TOTAL LOCAL (H)		
1	24	27	65	2	118	8	2	10	128	
2	24	26	46	3	99	20	0	20	117	
3	20	22	48	6	96	2	0	2	98	
4	24	26	269	0	319	226	0	226	545	
5	24	26	357	0	407	218	0	218	625	
6	26	32	287	1	346	110	0	110	456	
7	22	32	236	1	291	240	0	240	531	
8	23	34	111	6	174	62	2	64	238	
9	26	29	138	4	197	60	0	60	257	
10	24	26	89	0	139	36	0	36	175	
11	24	23	36	0	83	0	0	0	83	
12	24	32	232	3	291	172	0	172	463	
13	23	24	333	2	382	184	0	184	566	
14	22	28	221	2	273	196	0	196	469	
15	22	28	121	2	173	154	0	154	327	
16	25	31	229	10	295	186	0	186	481	
17	25	34	223	0	282	190	14	204	486	
18	25	23	239	0	287	278	0	278	565	
19	22	23	451	0	496	52	0	52	548	
20	24	35	265	0	324	154	0	154	478	
21	24	41	246	4	315	288	0	288	603	
22	23	29	160	2	214	174	0	174	388	
23	24	28	282	4	338	158	0	158	496	
24	24	39	283	3	349	256	0	256	605	
25	24	25	297	0	346	188	0	188	534	
26	24	23	70	5	122	8	0	8	130	
27	25	27	45	1	98	0	0	0	98	
28	20	27	89	2	138	52	0	52	190	
29	24	30	201	12	267	128	2	130	397	
30	24	29	119	8	180	108	0	108	288	
31	24	28	123	6	181	52	0	52	233	
TOTAL	733	887	5911	89	7620	3960	20	3980	11600	

FAA Form 7230-1 (10-71) SUPERSEDES PREVIOUS EDITION

C FAA AC 73-1247

FIGURE 2

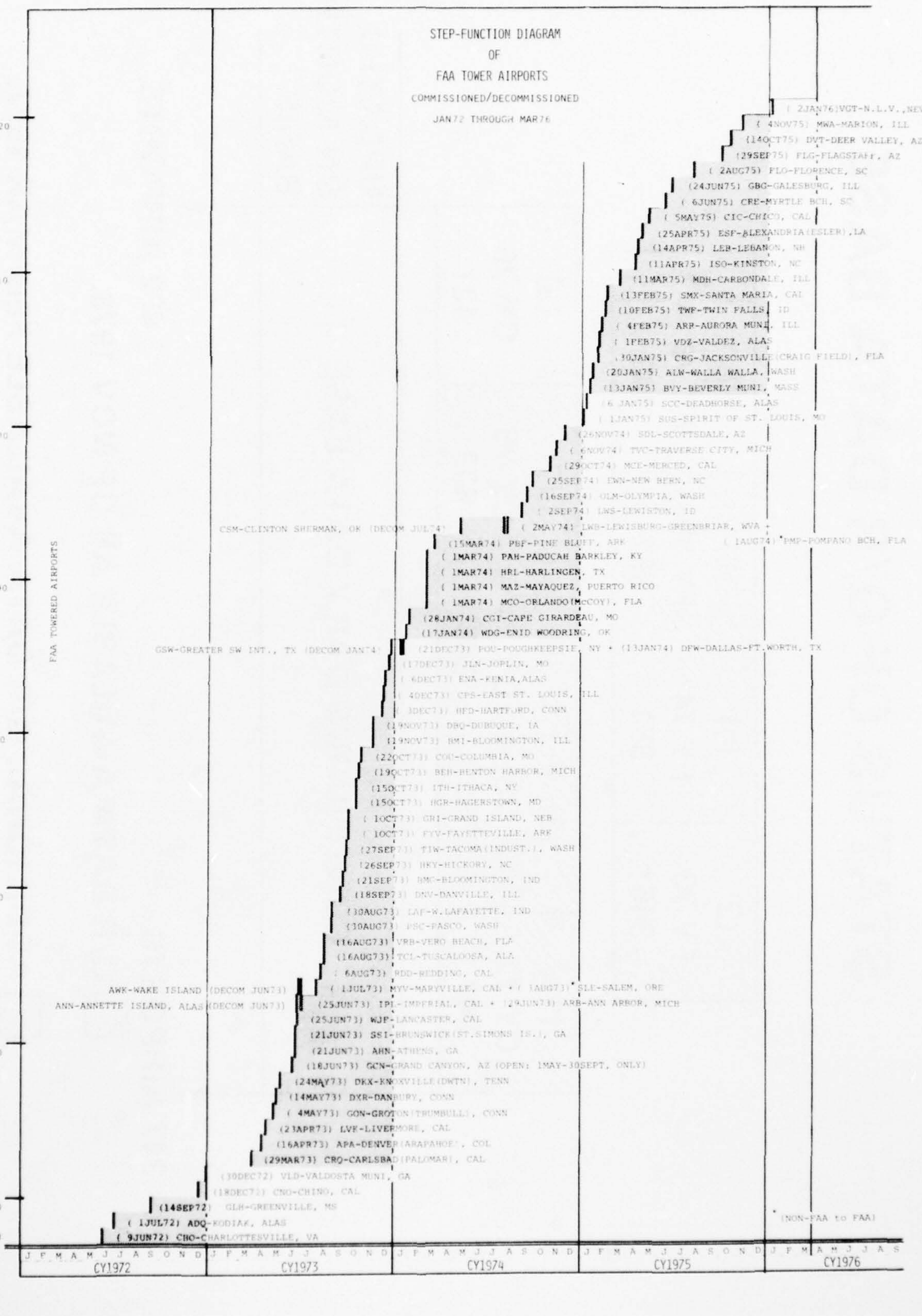

STEP-FUNCTION DIAGRAM
OF
FAA TOWER AIRPORTS
COMMISSIONED/DECOMMISSIONED
JAN72 THROUGH MAR76
FAA TOWERED AIRPORTS
420
410
400
390
380
370
360
350
348
(2JAN76) VGT-N.L.V., NEV
(4NOV75) MWA-MARION, ILL
(14OCT75) DVT-DEER VALLEY, AZ
(29SEP75) FLG-FLAGSTAFF, AZ
(2AUG75) FLO-FLORENCE, SC
(24JUN75) GBG-GALESBURG, ILL
(6JUN75) CRE-MYRTLE BCH, SC
(5MAY75) CIC-CHICO, CAL
(25APR75) ESF-ALEXANDRIA(ESLER),LA
(14APR75) LEB-LEBANON, NH
(11APR75) ISO-KINSTON, NC
(11MAR75) MDH-CARBONDALE, ILL
(13FEB75) SMX-SANTA MARIA, CAL
(10FEB75) TWF-TWIN FALLS, ID
(4FEB75) ARR-AURORA MUNI, ILL
(1FEB75) VDZ-VALDEZ, ALAS
(30JAN75) CRG-JACKSONVILLE(CRAIG FIELD), FLA
(20JAN75) ALW-WALLA WALLA, WASH
(13JAN75) BVY-BEVERLY MUNI, MASS
(6JAN75) SCC-DEADHORSE, ALAS
(1JAN75) SUS-SPIRIT OF ST. LOUIS, MO
(26NOV74) SDL-SCOTTSDALE, AZ
(6NOV74) TVC-TRAVERSE CITY, MICH
(29OCT74) MCE-MERCED, CAL
(25SEP74) EWN-NEW BERN, NC
(16SEP74) OLM-OLYMPIA, WASH
(2SEP74) LWS-LEWISTON, ID
CSM-CLINTON SHERMAN, OK (DECOM JUL74)
(2MAY74) LWB-LEWISBURG-GREENBRIAR, WVA
(1AUG74)* PMP-POMPANO BCH, FLA
(15MAR74) PBF-PINE BLUFF, ARK
(1MAR74) PAH-PADUCAH BARKLEY, KY
(1MAR74) HRL-HARLINGEN, TX
(1MAR74) MAZ-MAYAQUEZ, PUERTO RICO
(1MAR74) MCO-ORLANDO(McCOY), FLA
(28JAN74) CGI-CAPE GIRARDEAU, MO
(17JAN74) WDG-ENID WOODRING, OK
GSW-GREATER SW INT., TX (DECOM JAN74)
(21DEC73) POU-POUGHKEEPSIE, NY * (13JAN74) DFW-DALLAS-FT.WORTH, TX
(17DEC73) JLN-JOPLIN, MO
(6DEC73) ENA-KENIA,ALAS
(4DEC73) CPS-EAST ST. LOUIS, ILL
(3DEC73) HFD-HARTFORD, CONN
(19NOV73) DBQ-DUBUQUE, IA
(19NOV73) BMI-BLOOMINGTON, ILL
(22OCT73) COU-COLUMBIA, MO
(19OCT73) BEH-BENTON HARBOR, MICH
(15OCT73) ITH-ITHACA, NY
(15OCT73) HGR-HAGERSTOWN, MD
(1OCT73) GRI-GRAND ISLAND, NEB
(1OCT73) FYV-FAYETTEVILLE, ARK
(27SEP73) TIW-TACOMA(INDUST.), WASH
(26SEP73) HKY-HICKORY, NC
(21SEP73) BMG-BLOOMINGTON, IND
(18SEP73) DNV-DANVILLE, ILL
(30AUG73) LAF-W.LAFAYETTE, IND
(30AUG73) PSC-PASCO, WASH
(16AUG73) VRB-VERO BEACH, FLA
(16AUG73) TCL-TUSCALOOSA, ALA
(6AUG73) RDD-REDDING, CAL
AWK-WAKE ISLAND (DECOM JUN73)
(1JUL73) MYV-MARYVILLE, CAL * (1AUG73)* SLE-SALEM, ORE
ANN-ANNETTE ISLAND, ALAS (DECOM JUN73)
(25JUN73) IPL-IMPERIAL, CAL * (29JUN73) ARB-ANN ARBOR, MICH
(25JUN73) WJF-LANCASTER, CAL
(21JUN73) SSI-BRUNSWICK(ST.SIMONS IS.), GA
(21JUN73) AHN-ATHENS, GA
(18JUN73) GCN-GRAND CANYON, AZ (OPEN: 1MAY-30SEPT. ONLY)
(24MAY73) DKX-KNOXVILLE(DWTN), TENN
(14MAY73) DXR-DANBURY, CONN
(4MAY73) GON-GROTON(TRUMBULL), CONN
(23APR73) LVK-LIVERMORE, CAL
(16APR73) APA-DENVER(ARAPAHOE), COL
(29MAR73) CRQ-CARLSBAD(PALOMAR), CAL
(30DEC72) VLD-VALDOSTA MUNI, GA
(18DEC72) CNO-CHINO, CAL
(14SEP72) GLH-GREENVILLE, MS
(1JUL72) ADQ-KODIAK, ALAS
(9JUN72) CHO-CHARLOTTESVILLE, VA
* (NON-FAA to FAA)
J F M A M J J A S O N D
CY1972
CY1973
CY1974
CY1975
CY1976

FIGURE 3

STATUS OF Q/R DATA BASE

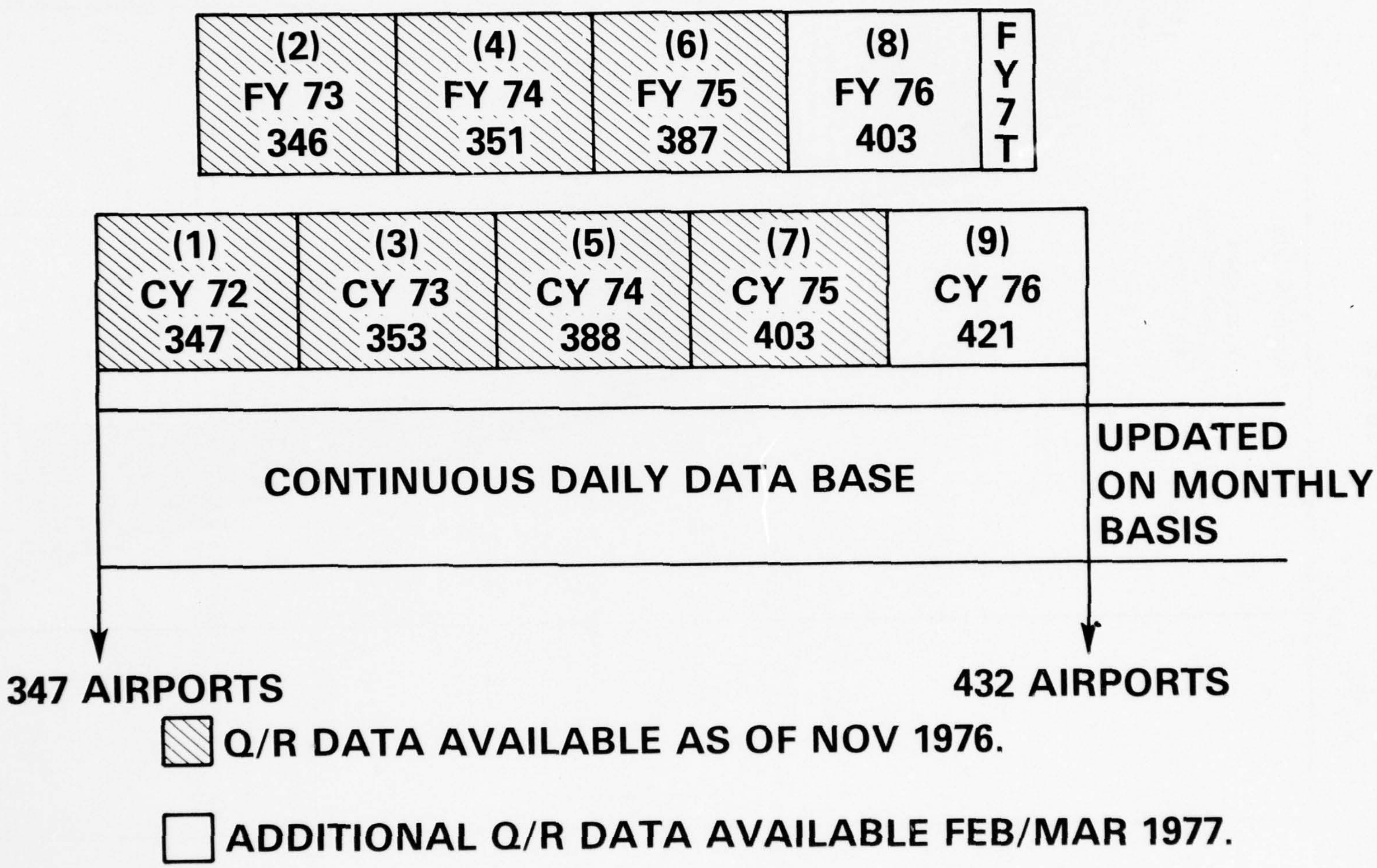


Figure 4

QUICK-RESPONSE OUTPUT TABLES & CURVES

1. SINGLE AIRPORT ACTIVITY STATISTICS TABLES (@ AIRPORT)
2. AVERAGE AIRPORT ACTIVITY STATISTICS TABLES (AIRPORT GROUPINGS)
3. AVERAGE DAILY OPERATIONS TABLES (@ AIRPORT)
4. FREQUENCY DISTRIBUTION HISTOGRAMS & $\boxed{\text{TABLES}}$
5. ANNUAL DISTRIBUTION OF AIRPORT ACTIVITY CURVES & $\boxed{\text{TABLES}}$
6. $\boxed{\text{PEAK-TO-AVERAGE ACTIVITY ANALYSIS CURVES & TABLES}}$

$\boxed{}$ = NOT AVAILABLE IN HANDBOOKS

Figure 5

TABLE: 1 - 64 SINGLE AIRPORT ACTIVITY STATISTICS CY 1975

REGION: EASTERN
STATE: VIRGINIA
AIRPORT ID/LOCATION: IAD - WASHINGTON DULLES INTERNATIONAL

AIRPORT STATISTICS	ITINERANT OPERATIONS AIR CARRIER	AIR TAXI	GENERAL AVIATION	MILIT.	TOTALS	LOCAL OPERATIONS GENERAL AVIATION	MILIT.	TOTALS
DAILY AVERAGE (365 DAYS)	149	21	158	17	346	84	56	141
DAILY ST. DEV.	12	12	49	12	64	44	53	78
PEAK DAILY OPS	188	50	285	58	499	202	320	404
PEAK DAY	MON	WED	FRI	MON	TUE	TUE	THU	THU
PEAK DATE	25AUG	22OCT	21MAR	24NOV	14OCT	10JUN	10APR	10APR
(PEAK/AVG RATIO)	(1.26)	(2.38)	(1.80)	(3.41)	(1.44)	(2.40)	(5.71)	(2.87)
WEEKLY AVERAGE (51 WEEKS)	1044	148	1115	123	2431	592	401	994
WEEKLY ST. DEV.	54	38	160	29	214	123	126	209
PEAK WEEKLY OPS	1153	225	1410	218	2849	889	730	1496
PEAK WEEK (SUN)	9NOV	19OCT	26OCT	2NOV	26OCT	18MAY	9FEB	9FEB
MONTHLY AVERAGE (12 MONTHS)	4539	638	4813	529	10519	2568	1714	4281
MONTHLY ST. DEV.	243	136	521	70	780	222	308	427
PEAK MONTHLY OPS	4851	976	5580	664	11717	3195	2090	5234
PEAK MONTH	AUG	OCT	MAY	NOV	OCT	MAY	APR	MAY
1ST QTR TOTALS (JAN-MAR)	13031	1634	12990	1468	29123	7377	4997	12374
2ND QTR TOTALS (APR-JUN)	13429	1679	15630	1682	32420	8413	5571	13984
3RD QTR TOTALS (JUL-SEP)	14239	1864	14552	1505	32160	7399	4610	12009
4TH QTR TOTALS (OCT-DEC)	13765	2476	14583	1698	32522	7621	5389	13010
ANNUAL TOTALS	54464	7653	57755	6353	126225	30810	20567	51377

FIGURE 6

TABLE: 5-1 ANNUAL DISTRIBUTION OF AIRPORT ACTIVITY CY 1975

AIRPORT GROUP: U. S. A.
NO. OF AIRPORTS 403
TYPE OF OPERATION: ITINERANT

MONTH	ITINERANT OPERATIONS AIR CARRIER	AIR TAXI	GENERAL AVIATION	MILITARY
1	1942	538	4133	231
2	1743	482	3975	221
3	1932	540	4702	253
4	1884	545	5113	286
5	1943	566	5543	302
6	1942	567	5432	289
7	2026	600	5851	273
8	2017	605	5681	279
9	1871	561	5363	269
10	1935	599	5653	283
11	1818	525	4928	257
12	1784	544	4262	230

FIGURE 7

TABLE 5-1 ANNUAL DISTRIBUTION OF AIRPORT ACTIVITY CY 1975
NO. OF AIRPORTS 403
TYPE OF OPERATION ITINERANT

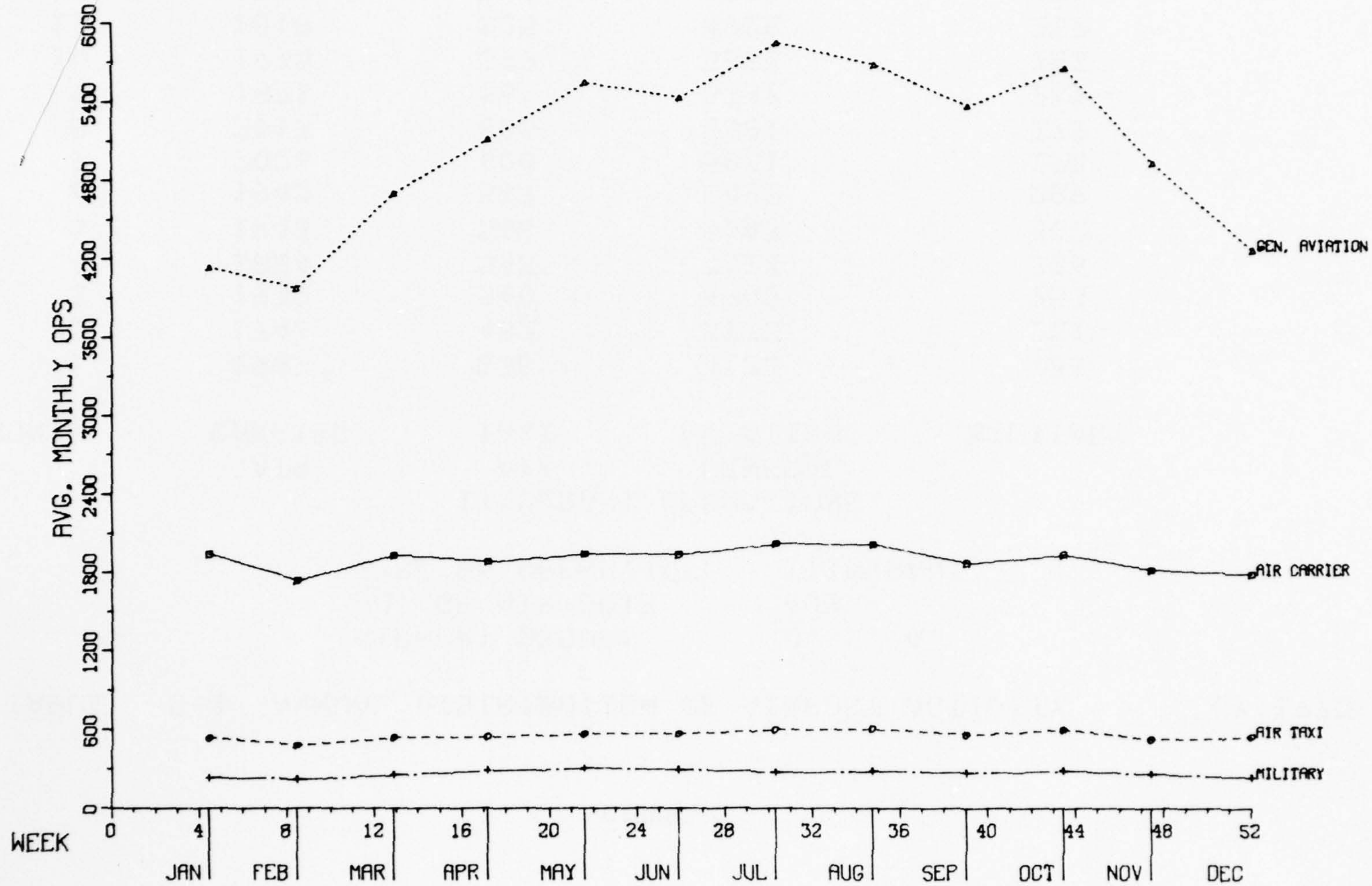


FIGURE 8

TABLE: 6- 1 PEAK TO AVERAGE ACTIVITY ANALYSIS CY 1975

AIRPORT GROUP: STATE OF VIRGINIA
NO. OF AIRPORTS: 7
TYPE OF OPERATION: TOTAL OPERATIONS

MONTH	AVERAGE OPERATIONS	FIRST PEAK	AIRPORT	SECOND PEAK	AIRPORT
1	9437	13420	IAD	13354	RIC
2	9071	13701	IAD	11914	RIC
3	10421	14376	IAD	14312	PHF
4	11026	15129	PHF	14647	IAD
5	11950	16559	IAD	16368	PHF
6	12179	17649	PHF	15198	IAD
7	11354	15442	PHF	14971	IAD
8	11604	16669	PHF	14645	IAD
9	11005	15685	PHF	14553	IAD
10	12185	16428	PHF	16161	IAD
11	11511	16095	PHF	15803	IAD
12	9502	13568	IAD	12431	RIC

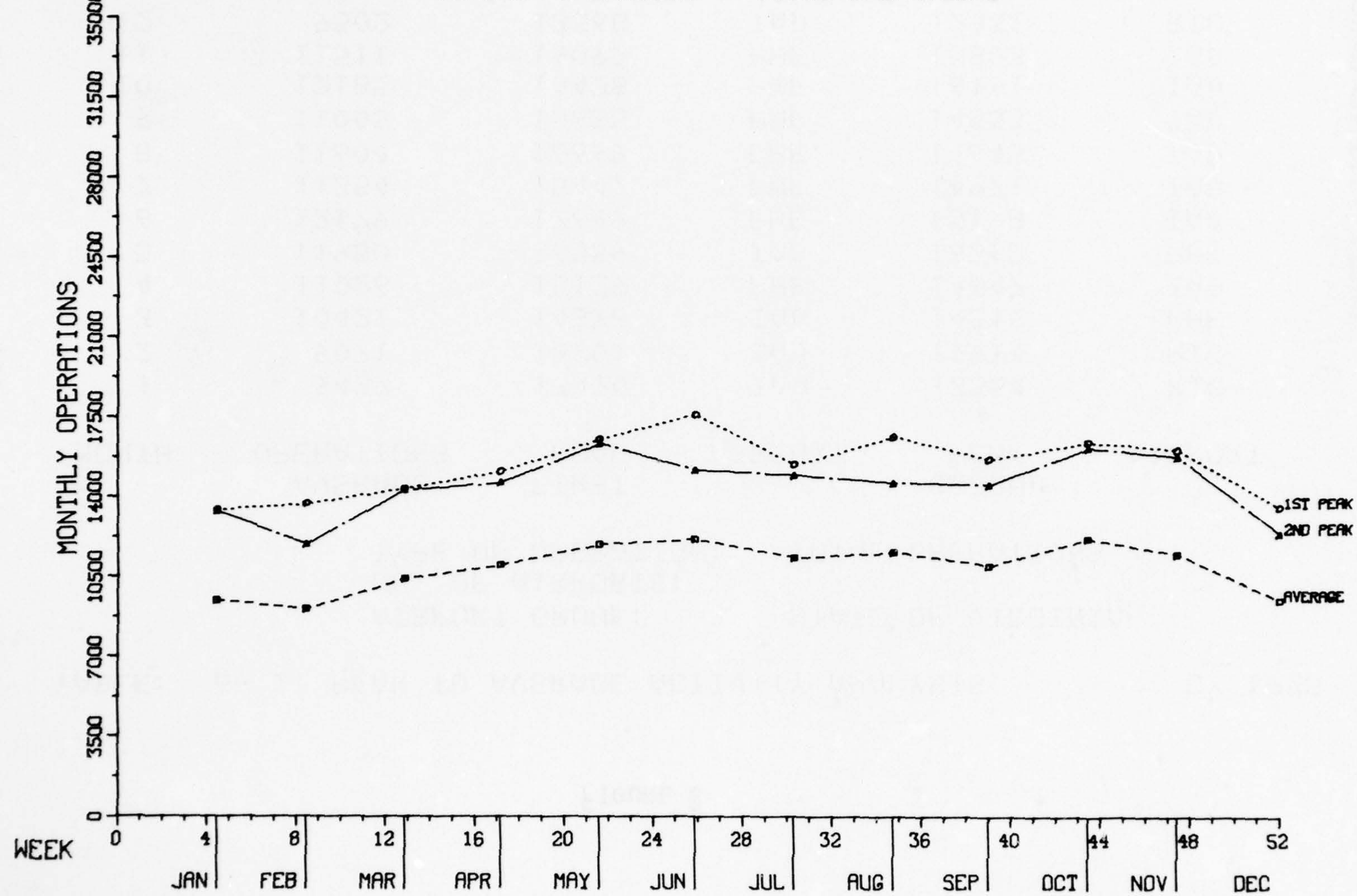
Figure 9

TABLE 6-1 PEAK TO AVERAGE ACTIVITY ANALYSIS CY 1975

AIRPORT GROUP STATE OF VIRGINIA

NO. OF AIRPORTS 7

TYPE OF OPERATION TOTAL OPERATIONS



FORECASTING NATIONWIDE GENERAL AVIATION OPERATIONS

- Bruce L. Brown
Senior Project Manager
Systems Consultant, Incorporated

My topic is general aviation; more specifically, it is general aviation forecasting. But I believe that the most significant point to be made in this discussion is that a new statistic has been developed to help in assessing General Aviation and its trends. We are now able to measure the extent of general aviation (GA) activity at the state, regional and national levels. Airport operations are the unit of measure. Moreover, forecasting procedures have been developed and enable estimates to be made of future GA activity levels. These operations forecasts are applicable to the entire general aviation community; they include activity estimates at both towered and non-towered airports.

It may be appropriate to first distinguish these forecasts from those presented earlier in the morning session. The GA activity data presented this morning apply to the nation's 428 airports where FAA traffic control services are available. On the other hand, these data address what takes place at all the country's 14,000 airports. Although both topics address GA activity forecasts, there are major differences in their comparative levels of operations and more significantly in their rates of growth expected. This should not imply that the two forecasts are contradictory. Rather, each forecast is applied to different portions of GA in order to meet its separate objectives. One addresses the segment of GA that impacts on the traffic control facilities, the other addresses the whole of general aviation. Tower forecasts are necessary to properly plan for future FAA facility and manpower requirements. Nationwide activity estimates are intended to better reflect GA's overall condition as it exists through the country.

The national level forecasts of General Aviation Operations are exhibited in Table A-1, Appendix A, of the forecast document, FAA-AVP-76-17 Aviation Forecasts, FY 1977-1988. To further illustrate, State forecasts for the FAA Great Lakes (GL) Region are shown on the next slide (see Figure 1). It should be mentioned that these exhibits, generated last year, represent values which are about 6 percent higher than the current forecast. Our present national level of operations is 133 million; local operations constitute almost 54 percent of the total. A five year forecast indicates an increase

of 24 percent from today's level; by 1986, we will have 200 million operations which represent half again the number of today's operations. The 217 million level projected for 1988 represents a 63 percent increase over today's level. This equates to an annual growth rate of 4.15 percent.

The forecasts exhibited here represent the aggregate of state forecasts. Those who are interested may review the state or regional level forecasts through the documents referenced at the end of this presentation. However, certain factual instances from state and regional estimates warrant mentioning:

- California leads the nation in GA; it has 14 percent of the total.
- Texas and Florida are runners-up with 7 and 6 percent.
- Rhode Island is the least active state with .2 percent, slightly behind Vermont with .3 percent.
- Great Lakes Region with 19 percent and the Western Region with 17 percent are the regional leaders.
- At the other end are New England and Rocky Mountain Regions with 4.5 and 4.6 percent.

These ratings of the leading states are similar to the conditions represented by the present tower statistics. However, reliance on tower statistics for a state's level of activity, or its relative importance, would be misleading. For example, on the average, nationwide, there are 2.1 operations at non-tower airports for each operation at a tower airport. Yet, in Maryland, only 10 percent of its GA occurs at tower airports; at the other extreme we can see that in West Virginia, 54 percent of its GA operations take place at tower airports. Tower statistics would indicate that California's GA represents 21 percent of the national total (rather than 14 percent).

Similarly, it is inappropriate to use the forecasted growth rates of tower airports as being representative of the national GA condition. Operations at towered airports increased 7.7 percent in this last year, but for General Aviation, nationwide, the comparative operations increase was only

2.1 percent. Again, let me clarify that these differences are not contradictory; rather they simply stress the fact that activity occurring at tower airports is not representative of the entire general aviation community. General Aviation is definitely growing, but an evaluation of its overall condition depends on its assessment at both towered and non-towered airports.

Finally, a few remarks that address the credibility of the forecasts. As you know, we do not collect data that will yield a nationwide or statewide statistic of GA operations that can be used as a reference for evaluation of the adequacy of forecasted values. Therefore, the forecast's credibility must be that which is associated with the forecast development process. These forecasts are the culmination of a three-phased development program that began several years ago. The first phase consisted of developing a model to estimate operations at any individual airport. In phase two, the mechanics for exercising the model and aggregating the operations at 2,500 non-towered airports were developed. And finally, the forecast was generated in the third phase. Forecasting relationships are the result of econometric modeling; general aviation operations are represented as a function of the size of the GA fleet and the number of pilots. FAA forecasts of these parameters serve as input values. Separate models were developed for total and local operations. The regression process operated on a pooled data base of 1972-1974 state characteristics. Further details regarding the development process are contained in the reports, FAA-AVP-76-6, Nationwide, Regional and Statewide Estimates for General Aviation (GA) Activity at Nontowered Airports During CY 1972 (Revised) and CY 1974; FAA-AVP-76-7, General Aviation Forecasts, 1975-1987, State, Regional National Operations; and FAA-RD-74-177, Development of a Non-Survey Method Estimating Traffic at Non-Towered Airports.

TABLE A-1 NATIONAL FORECAST OF TOTAL GENERAL AVIATION OPERATIONS AT TOWERED AND NONTOWERED AIRPORTS 1/

(In millions)

CALENDAR YEAR	TOTAL OPERATIONS	LOCAL OPERATIONS	ITINERANT OPERATIONS
1972 2/	115.4	63.8	51.6
1974 2/	125.7	67.9	57.8
1975	130.7	70.2	60.5
1976	135.4	72.9	62.5
1977	141.2	76.4	64.8
1978	146.8	80.7	66.1
1979	153.4	84.5	68.9
1980	157.6	87.3	70.3
1981	163.6	90.7	72.9
1982	171.5	95.1	76.4
1983	180.8	100.3	80.5
1984	190.6	105.9	84.7
1985	200.4	111.8	88.6
1986	211.6	118.4	93.2
1987	222.5	125.0	97.5

1/ Taken from Report No. FAA-AVP-76-7

2/ Estimates from Report No. FAA-AVP-76-6

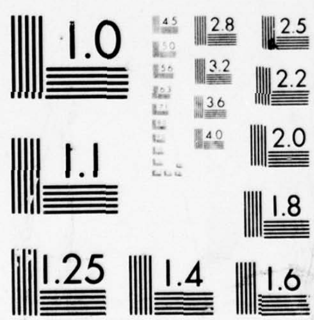
AD-A040 065 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C OFFICE--ETC F/G 5/3
AVIATION FORECASTS FY 1977 - 1988, SUMMARY AND BRIEFING CONFERE--ETC(U)
DEC 76

UNCLASSIFIED FAA-AVP-77-16 NL

3 OF 3
AD
A040065

END
DATE
FILMED
6-77

040 06



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Figure 1

FORECAST OPERATIONS FOR STATES IN GREAT LAKES REGION

(in thousands)

REGION=GL

	IL	IN	MI	MN	OH	WI	TOTAL
1975							
TOTAL	5644	3025	5572	2448	5944	2932	25567
LOCAL	3076	1530	3037	1294	3215	1502	13657
ITN.	2567	1495	2534	1153	2728	1430	11910
1976							
TOTAL	5851	3139	5751	2560	6149	3018	26471
LOCAL	3194	1598	3146	1357	3338	1553	14188
ITN.	2657	1540	2605	1202	2811	1465	12282
1977							
TOTAL	6113	3279	5972	2701	6404	3124	27594
LOCAL	3354	1689	3290	1442	3502	1619	14899
ITN.	2758	1589	2681	1259	2901	1504	12694
1978							
TOTAL	6351	3409	6177	2830	6638	3222	28630
LOCAL	3541	1795	3457	1539	3694	1696	15725
ITN.	2810	1613	2719	1290	2944	1525	12904
1979							
TOTAL	6647	3567	6425	2989	6926	3341	29899
LOCAL	3710	1892	3610	1628	3868	1767	16478
ITN.	2936	1675	2815	1360	3057	1574	13420
1980							
TOTAL	6836	3672	6591	3092	7114	3420	30727
LOCAL	3838	1965	3726	1696	4000	1821	17048
ITN.	2998	1706	2864	1395	3114	1599	13679
1981							
TOTAL	7102	3816	6818	3236	7375	3529	31878
LOCAL	3986	2051	3862	1776	4153	1884	17715
ITN.	3115	1765	2956	1460	3221	1644	14163
1982							
TOTAL	7456	4006	7116	3426	7719	3671	33397
LOCAL	4183	2163	4040	1879	4356	1966	18591
ITN.	3272	1842	3075	1546	3363	1704	14805
1983							
TOTAL	7863	4227	7464	3646	8118	3837	35158
LOCAL	4409	2293	4246	1999	4589	2062	19601
ITN.	3454	1933	3217	1646	3529	1775	15556
1984							
TOTAL	8295	4462	7835	3880	8543	4015	37032
LOCAL	4654	2435	4471	2131	4842	2167	20703
ITN.	3640	2026	3363	1748	3700	1848	16329
1985							
TOTAL	8736	4704	8216	4119	8978	4197	38953
LOCAL	4921	2589	4715	2273	5118	2281	21900
ITN.	3814	2114	3500	1845	3860	1916	17053
1986							
TOTAL	9236	4976	8646	4390	9470	4403	41124
LOCAL	5218	2760	4986	2431	5424	2406	23226
ITN.	4018	2216	3660	1958	4046	1996	17897
1987							
TOTAL	9706	5231	9046	4643	9930	4594	43153
LOCAL	5500	2921	5242	2580	5714	2525	24485
ITN.	4206	2309	3804	2063	4215	2069	18668

THE IMPACT OF FBO ACTIVITY AT NONTOWERED AIRPORTS

- Lawrence L. Burian
President & Chief Executive Officer
National Air Transportation Association (NATA)

Thank you for that glowing introduction, Mr. Hines. I might add that you have asked me to cover a subject in 8 minutes that has taken about 7 decades to develop into what it is today. My subject, "The Impact of FBO Activity at Nontowered Airport," could easily go by another title. The one that I prefer is "FBOs . . . the Vital Link in the Nation's Air Transportation System."

Several weeks ago - when I was approached by AVP - I questioned my participation in this forecast session, especially after taking a look at the lineup of experts that would be taking part in it. What would be my role? What could I contribute? Those were the questions I asked myself and Gene Mercer and Jim Hines. And after hearing the people before me, I still must ask myself those same questions. However, perhaps I'll be able to shed some light on our industry . . . that of FBOs, in order that you will have a better understanding or our segment of the aviation industry thus enabling you - the forecasts experts - to take the FBO industry into consideration for future forecasts and to do a better job. If I can impart a better understanding of the so-called FBO, then my time here today will have been well spent and meaningful for both you and I.

I'm reminded of the story of the little girl asking her mother these searching questions: "Who brings us all those wonderful presents at Christmas-time?" she asked. "Why, Santa, of course," replied mother. "Who brings babies, mother?" Lovingly, the mother answered, "The stork." Looking for more answers, the little girl queried, "Who protects us from bad people?" Routinely the mother responded, "The police, honey." Confused, the little girl summed-up the conversation with the total question. "Mother, if Santa brings us presents, the stork brings us babies and the police protects us . . . then what do we need with daddy?" I might use that story as the vehicle for me to play the part of the Devil's advocate by asking "What do we need with the FAA?" Or, "What good do we get out of these forecast sessions?" I believe you'll agree that the answers are obvious. Of course we need an agency to help guide a huge industry like aviation--and we need planning in the form of these forecast sessions and the forecasts that come out of them to help us in our R&D and to measure our performance.

If I might depart from my subject for just a moment, I would like to inject a thought that will help FAA do a better planning job in the future. Specifically, I refer to a session that took place this morning, "Air Service to the Small Communities", dealing with the importance the commuter airline industry plays in our system. I was surprised and disappointed to learn that FAA did not have a reputable sopkesman from the commuter industry on the program. It is my opinion that this type of an omission is serious and can deter from meaningful forecasts and should be corrected.

Every airplane must have a home! The home of course is the FBO. Now let's get started off on the right foot by understanding the term FBO and that it means "fixed base operator". FBO is frequently used interchangeably with the phrases "airport service organization", "airport service operator" or "aviation support business". They all mean the same . . . a home for airplanes . . . the FBO, the aviation support business that is found at both towered and nontowered airports.

Speaking of airports, you should know that there are more than 13,000 airports in the United States. Airports of all sizes and descriptions. But for purposes of identifying the FBO, I'm going to restrict my remarks to approximately half of those 13,000 airports I just spoke of, or the more than 7,000 airports that are open to the public. Why? Because it is at these 7,000-plus airports that you will find the aviation business person we refer to as the FBO that has so much influence on the national air transportation system and the Nation's economy itself. These airports are the chunks of real estate - 100 acres, 150 acres or more - where FBOs are found servicing the day-to-day and the away-from-home needs of the more than 167,000 registered civil aircraft.

At each of these airports - and you'll usually find many within a 100-mile radius of any city of size - there is always one, two, three or more FBOs conducting the business that is so vital to our industry. All competing with each other, but all having the same common goal: a better system.

To further modify the level of activity at the 7,000-plus public use airports, according to the most recent published FAA statistics, "FAA Air Traffic Activity - FY 1975", the majority of all general aviation operations occur at airports where there are two or more sources of retail fuel. The top 200 airports in the nation handle three out of every four tower-controlled general aviation itinerant operations. At these top 200 airports, 70 percent of the general aviation operations involve locations where there are two or more fixed base operators in direct competition, and half involve locations with three or more such operators.

The airport service operator does a big job for his community because not only is he the key player in general aviation activity, but he is often the link to the certificated airlines through an added specialization of air taxi carriage of passengers and cargo, thus providing many small or isolated communities throughout America the convenience and the absolute necessities afforded by the national air transportation system.

In many ways - direct and indirect - the FBO provides his community with a public benefit.

The activity of an FBO is proportional to the level of community and airport activity; and the FBO is the "umbrella" under which all general aviation activity is generated and from whom much of the support for certificated air carrier and Department of Defense activity receives sustenance. To watch FBO activity is to watch synergism at work.

For instance, growth - and that's what we're speaking of in this dynamic industry! - in flight school, air taxi or maintenance and avionics shop profit centers, under the "umbrella" I just mentioned, will undoubtedly be transformed into increased airport operations. An over-all growth in FBO activity will almost always have the effect of increased operations at an airport, I mean those other profit centers under the FBO "umbrella" such as fuel, typical real estate functions (i.e. ramp space, tie-down, hangar space, etc.), weather reporting, aircraft grooming, pilot/passenger lounge services, specialty shops, parking lots/garages, car rentals, motels and many more . . . limited only by your imagination.

In summary, I would like to touch on a few key points.

First, with respect to air taxis, we must improve on the method of counting air taxi operations. FAA's current method of counting ranges anywhere from poor to awful and definitely needs and deserves some attention--perhaps a simplified reporting system that would expand slightly on the information now being gathered by CAB on Part 298 "air carriers." In any event, if FAA is going to have meaningful figures that will be worth the paper they are written on, upon which system demands are based, the accurate counting of air taxi operations must be a serious consideration and an integral part of all future forecasts.

Next, I hasten to mention that the airport service industry has never been included, nor is it included now, in FAA's Ten-Year Plan. This is a serious oversight! If you accept my simple description of FBO synergism, then you must accept the fact that FBO activity must be measured and injected in all future planning. On this note, I would like to point out that FAA passed-up the opportunity for Fiscal Years 1977 and 1978 to collaborate with NATA on an industry-wide study that would have given us a broad description - a pedigree if you will - of the ever-growing aviation service industry.

And lastly, I feel compelled to point out the fact that, nationally, FBOs show a labor force of about 150,000 full-time employees, or about two-thirds of all those employed in the general aviation industry, providing an almost immeasurable number of benefits to the millions of people across the country who seek the mobility and economy of air transportation and make a significant contribution to the Gross National Product.

In 1926, Colonel (now General) Billy Mitchell said, "If you were to measure the heartbeat of a city . . . take the pulse of her airport." And if you take the pulse of the city's airport, do it at the FBO. The FBO is the vital link between airports, planes and people.

TERMINAL AREA FORECASTING

- Jonathan Tom
Industry Economist, FAA

I would like to extend to you my own welcome to the FAA's second annual forecast conference. During the next 40 minutes, I'll talk about terminal area forecasting. In response to many suggestions based on last year's conference, the emphasis of this afternoon's session will be on forecasting methods and processes. My fellow panelist, Jack Duggan, will concentrate on various aspects of forecasting individual terminal areas, while I will discuss some ideas on forecasting activity at large numbers of terminals. After these discussions, we will entertain your questions on these topics.

Since I am wearing the hat of both moderator and speaker this afternoon, I have the rare opportunity of tooting my own horn. My name is Jonathan Tom, and I work for the FAA in the Aviation Forecast Branch. I have worked there for approximately three years in the capacity of Industry Economist. My work has been concentrated mainly in two forecast areas:

- o National aggregate forecasts of air carrier passenger traffic and general aviation activity, and

- o Terminal area aviation activity.

On that note, let us move on to the main theme of this discussion - developments in terminal area forecasting. As I mentioned before, I will discuss terminal forecasting from a macro or aggregate point of view.

In the last three years, the FAA has done a reasonable job forecasting aircraft operations on a national level. To illustrate this point, let us compare these forecasts with the available historical data (see Figure 1).

As we can see, the largest percentage error, 6.9 percent, occurred in the third forecast year of the 1973 forecast, while last year's forecast for fiscal year 1976 was less than one percent high.

Given that forecasts with errors of this small magnitude are adequate for overall planning purposes, one method of terminal area forecasting is to disaggregate these respectable national forecasts down to the airport level. As you may know, the FAA currently begins this disaggregation by applying the growth rates of the national forecast to the most recent activity data for each terminal. After this arithmetic operation, adding together the activity at all terminal areas for a given year should yield the previously forecasted national total for that same year. Thus, this process gives automatic consistency between the TAF and the national forecast.

This next two charts give the general idea. Letting the figures labeled A, B, & C in Figure 2 represent airports of equal size, with equal amounts of activity, they might all be expected to grow to a greater but equal size by 1988 (see Figure 3).

We are all aware, however, that this result is rare. Because the basic economies of some areas are growing faster than those of other areas, because some areas are developing recreational spots while others are less attractive, because one airport is becoming a popular international gateway, and for many other similar reasons, activity at some airports maintain the national growth rate (Figure 4) while some ariports grow more slowly than expected (Figure 5) and some grow more rapidly (Figure 6). At the same time, in aggregate, these three airports may achieve the expected total for 1988 (see Figure 7).

The simple diagrams just indicated dramatize the terminal area forecasting problem which I would like to discuss. That is, how does the forecaster maintain the integrity of a reliable national forecast, while accounting for differing economic and social conditions throughout the country?

To accommodate these regional characteristics, the disaggregation technique currently used in the Terminal Area Forecast relies on judgment. That judgment depends on information provided by the FAA field offices which are closer to individual airport problems, on analysis gathered from airport master plans, and on airport and hub studies conducted by the Office of Aviation Policy. It fine tunes the forecasts by "moving" aircraft operations from low growth areas into higher growth areas. Often, for example, expected future operations at a heavily used airport may be moved to surrounding reliever airports. This take-away-a-little-here-and-add-a-little-there technique

does preserve the forecasted national total activity levels, while allowing for some local impacts and deviations from the national growth pattern.

Making no comment on this judgmental technique (indeed, since forecasting is an art rather than a science, it ultimately depends on the judgment of the forecaster), the goal of the model builder is to provide a starting point which most closely approximates the real world.

To accomplish this objective, a model which forecasts different growth rates for different localities would be helpful. We are currently developing a model based on economic and aviation activity data disaggregated to the state level. This model will provide differing growth rates for each state based on three main impact:

- o Each state forecast will be dependent on individualized economic forecasts,
- o Different states may be sensitive to a different set of economic variables, and
- o States which have similar economic explanatory variables will have different sensitivities to them.

By way of clarification, let us examine some hypothetical examples. Here aviation activity levels in states A and B respond to the same economic variables in the same way. But if say the population of state A is growing faster than that of state B, aviation activity is expected to increase faster (see Figure 8).

Similarly, aircraft operations in state C may be dependent on population, while in state D annual income best explains changes in aviation activity (see Figure 9).

Finally, (as shown in Figure 10), the models for states E and F include the same economic variable, but each state responds to that variable differently. Even if the population of these states is growing at the same rate then, the individualized sensitivities will result in different forecasts.

Of course, various combinations of these three impacts will provide each state with its own forecast equation and its own aggregate forecast of aviation activity. Thus, we have solved half of this afternoon's problem; we have a forecast model which accounts for the differing conditions throughout the country.

But there is no guarantee that a sum of the forecasts for all 50 states for a given year will add to the "reliable" national forecast. In fact, such a condition is unlikely. How then can we achieve consistency between these two forecasts?

Given the national forecast as an aggregate constraint, the state of the modeling art provides us with a solution-- the forecasting of shares. By applying this idea to the state forecasts generated in the model mentioned above, each state's share of the national total activity can be determined for each year. The 1980 share for Alaska, for example, would be the model generated 1980 forecast for Alaska divided by the sum of the 1980 forecasts for all 50 states. Multiplying this share factor by the total 1980 activity generated from the national model yields a forecast for Alaska consistent with the national forecast.

The methodology described here is relatively simple (the complexities of building a state-by-state model notwithstanding). Yet it does provide a forecast based on a national forecast which does account for differing state characteristics.

But the model does have some limitations.

- First, it depends on forecasts of individual state economies. These forecasts, except in rare instances, can be obtained only from models using a top-down approach from national aggregates.

- And second, further disaggregation to the airport level is still required

Obviously, we have seen this last problem before. However, by beginning from an average state growth rate, the forecaster may be closer to the unique characteristics of an individual terminal area. From this basis, perhaps he can make better use of his judgment and give the planners a better terminal area forecast, a better planning tool.

Figure 1

FORECAST ERROR FOR TOTAL TOWER OPERATIONS
(IN MILLIONS)

FISCAL YEAR	1974	1975	1976
ACTUAL ACTIVITY	56.8	59.0	62.5
1973 FORECAST	59.1	62.3	66.8
PERCENT DIFFERENCE FROM ACTUAL	4.0%	5.6%	6.9%
1974 FORECAST		61.6	66.4
		4.4%	6.2%
1975 FORECAST			63.0
			0.8%

Figure 2

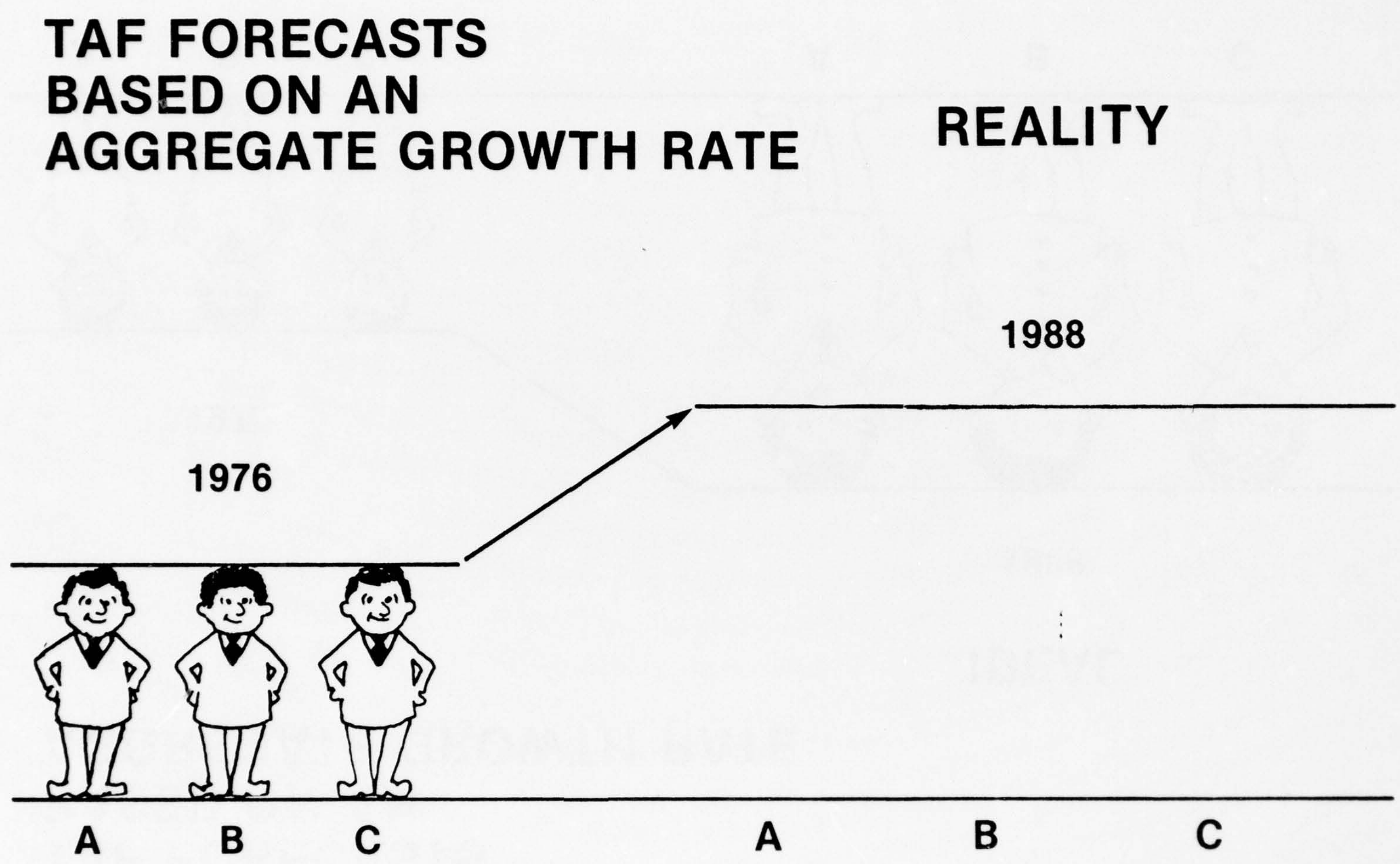

TAF FORECASTS
BASED ON AN
AGGREGATE GROWTH RATE
REALITY
1976
1988
A
B
C
A
B
C

FIGURE 3

TAF FORECASTS BASED ON AN AGGREGATE GROWTH RATE

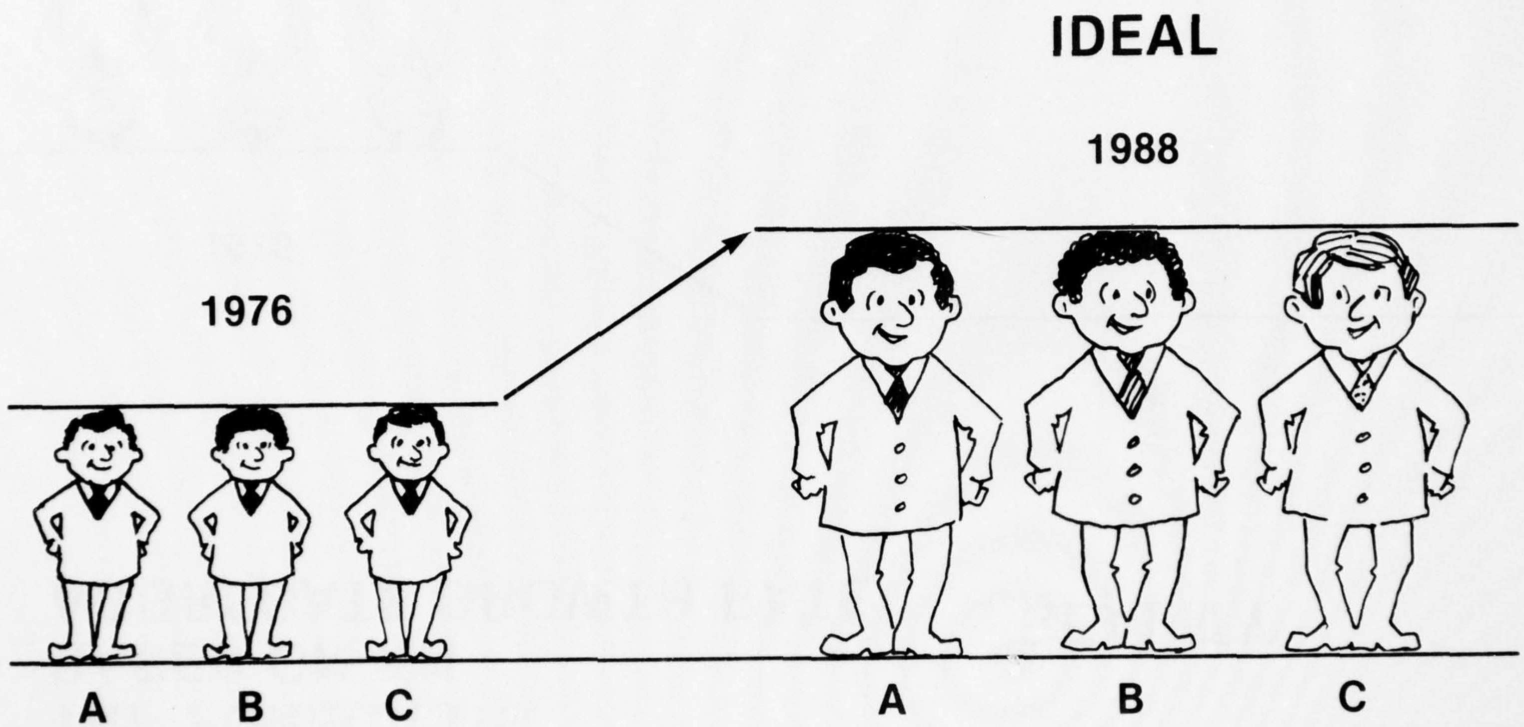


Figure 4

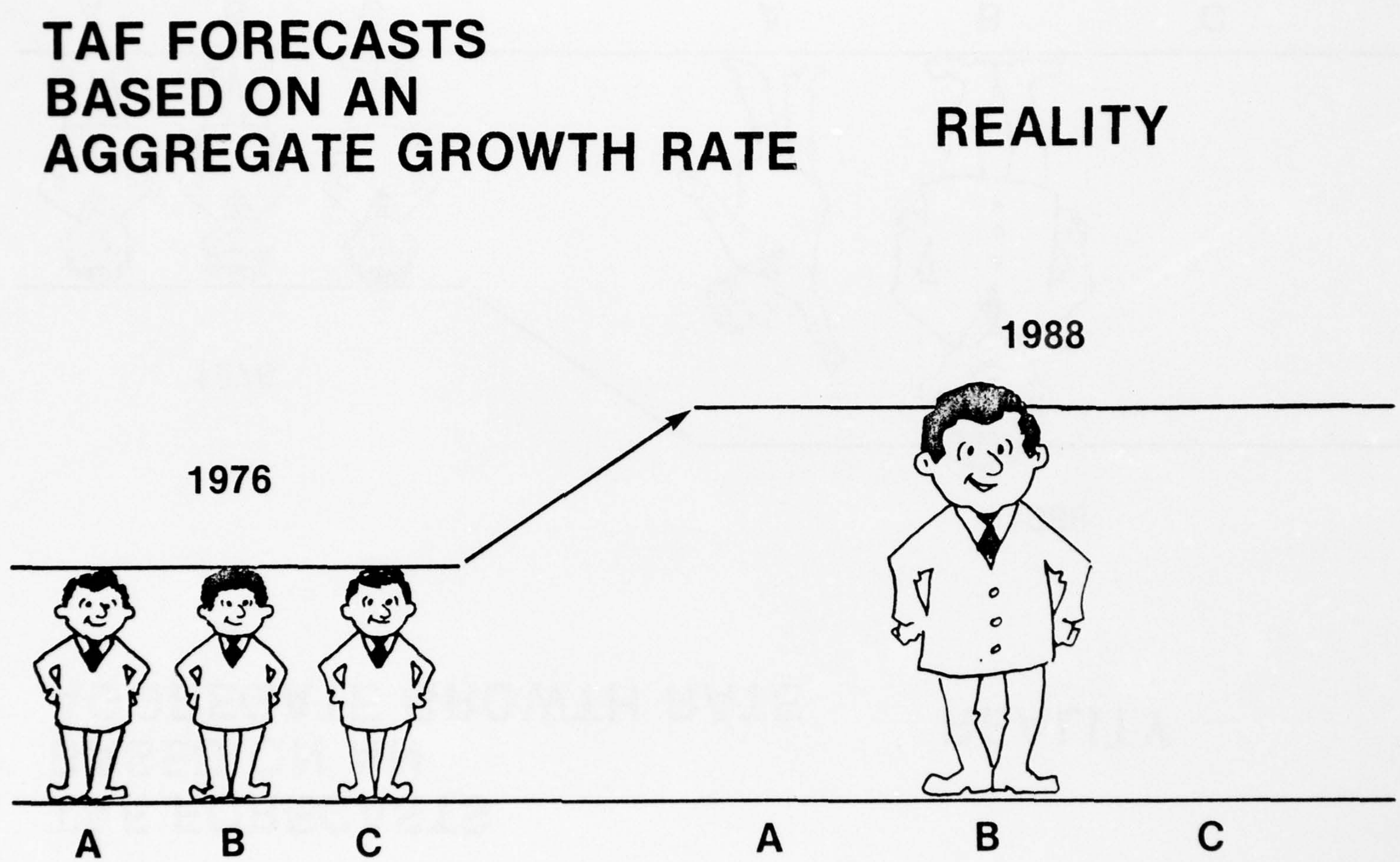
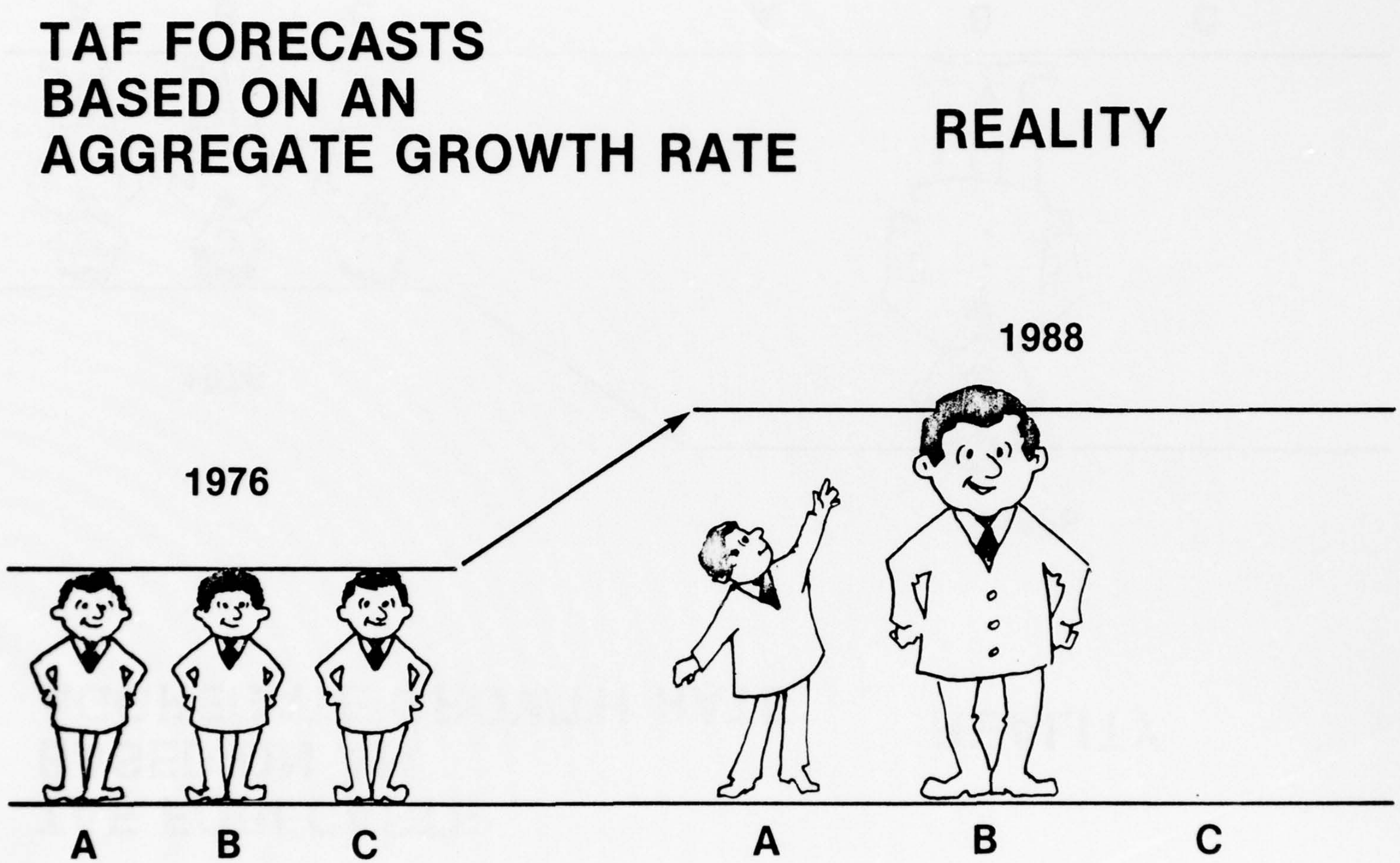

TAF FORECASTS
BASED ON AN
AGGREGATE GROWTH RATE
REALITY
1976
1988
A
B
C
A
B
C

FIGURE 5



TAF FORECASTS
BASED ON AN
AGGREGATE GROWTH RATE
REALITY
1976
1988
A
B
C
A
B
C

FIGURE 6

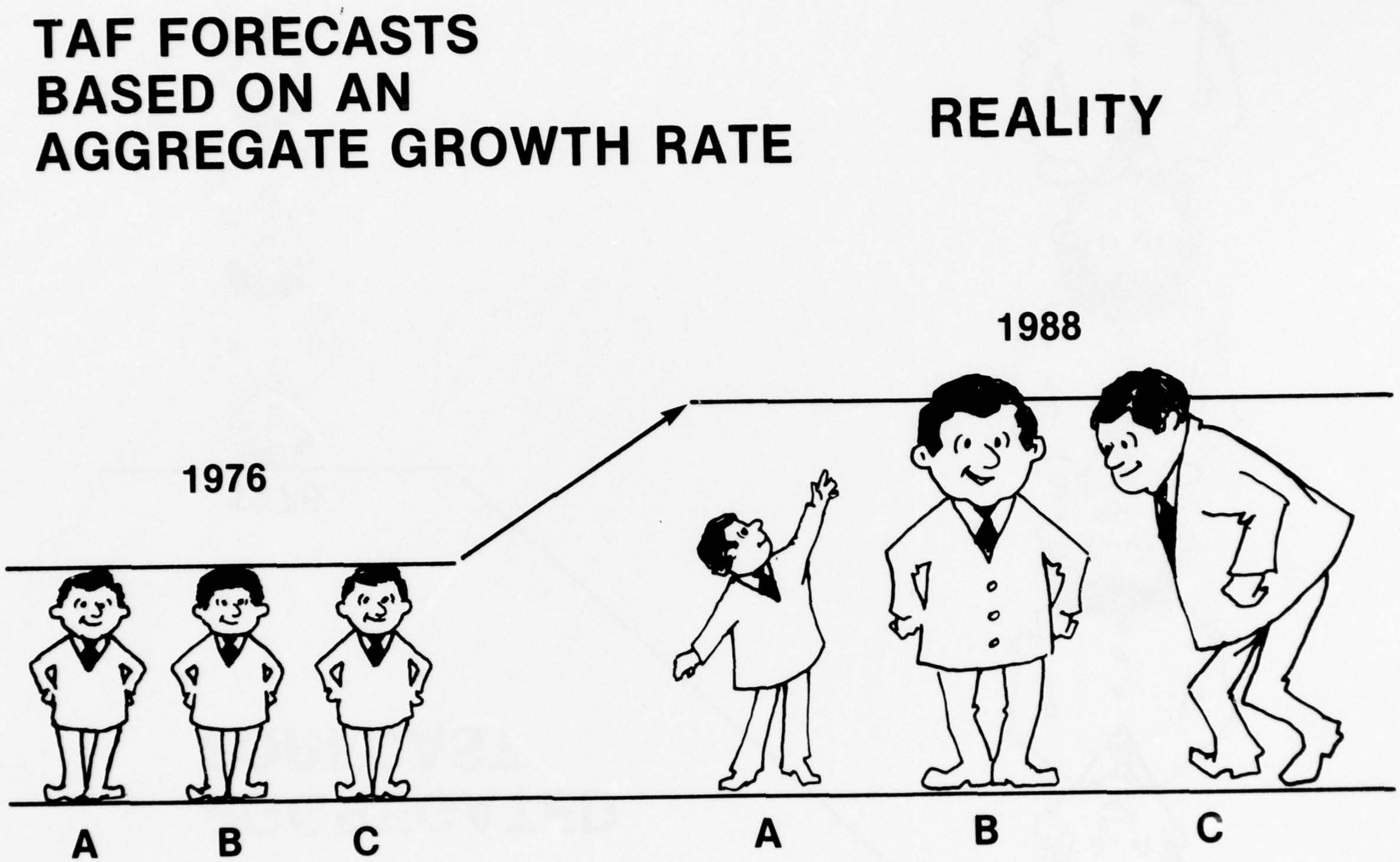

TAF FORECASTS
BASED ON AN
AGGREGATE GROWTH RATE
REALITY
1976
1988
A
B
C
A
B
C

Figure 7

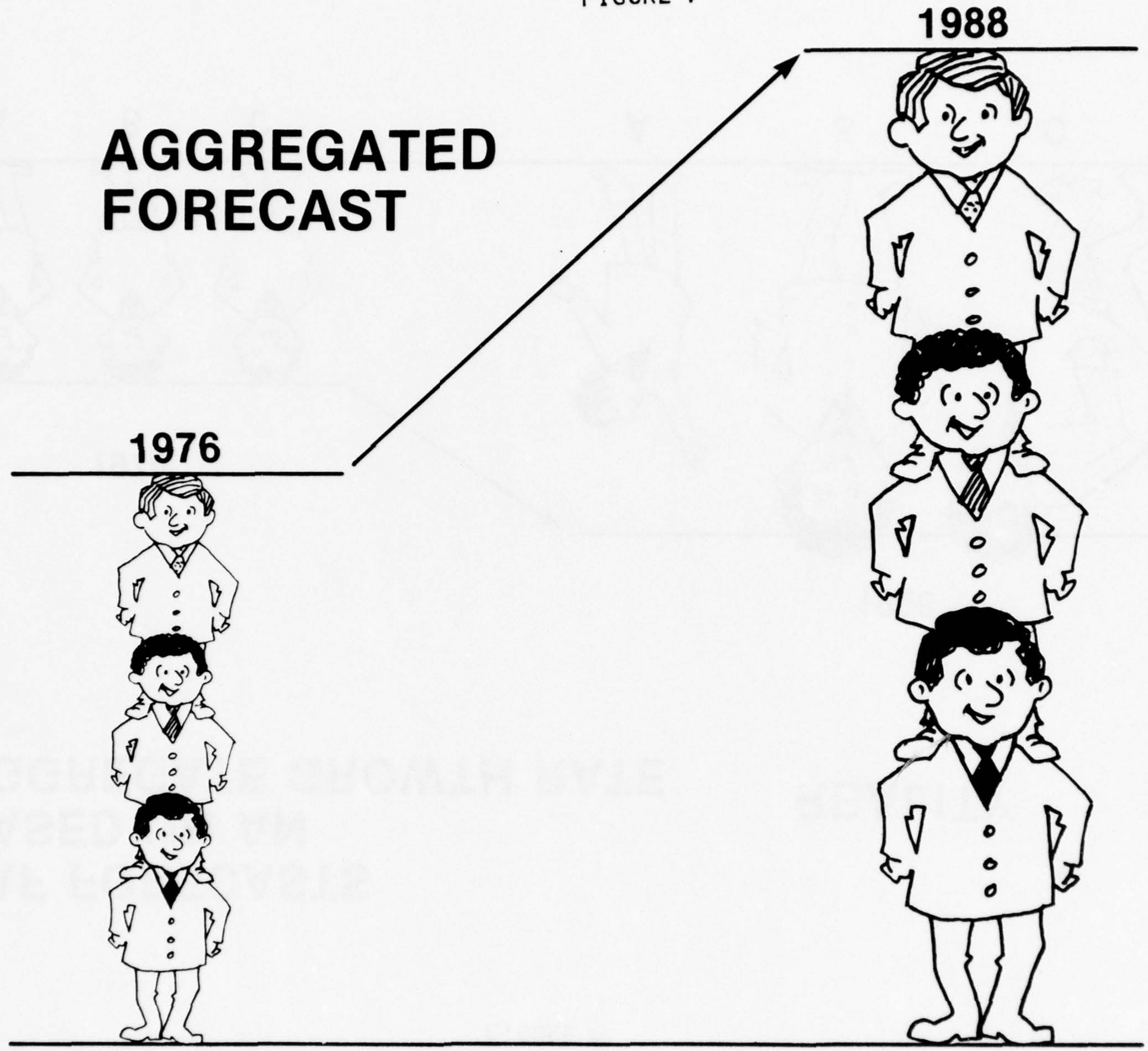
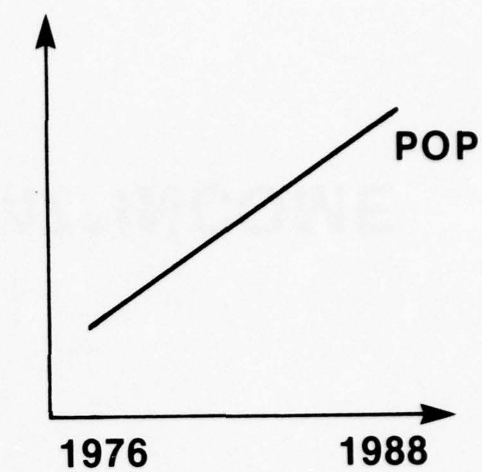


FIGURE 8

STATE A:

AIRCRAFT OPERATIONS = 3.5 + 0.89*POP



STATE B:

AIRCRAFT OPERATIONS = 3.5 + 0.89*POP

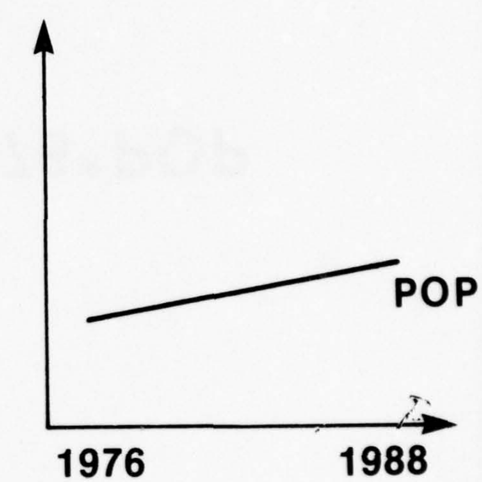


FIGURE 9

STATE C:

AIRCRAFT OPERATIONS = 8.9 + 0.76*POP

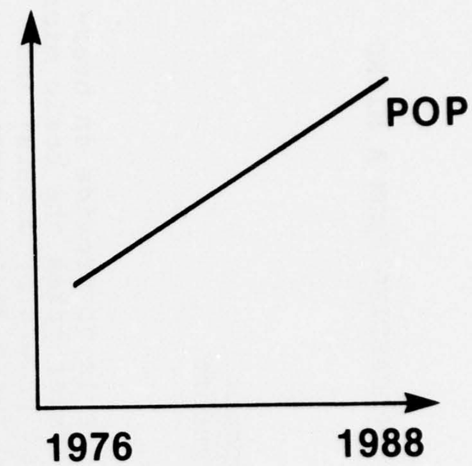
STATE D:

AIRCRAFT OPERATIONS = 7.4 + 0.47*INCOME

FIGURE 10

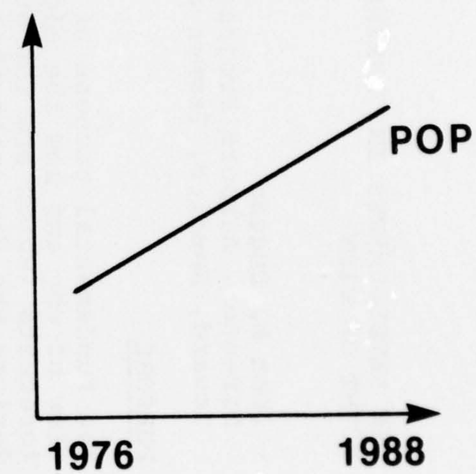
STATE E:

AIRCRAFT OPERATIONS $= 3.7 + 0.68*POP$



STATE F:

AIRCRAFT OPERATIONS $= 4.1 + 0.50*POP$



NEW DEVELOPMENTS IN TERMINAL AREA FORECASTING FROM A MICRO POINT OF VIEW

- John M. Duggan
Director, Airport Project Development
Howard, Needles, Tammen and Bergendoff

PURPOSE

The fundamental purpose of this paper is to provide an overview of why and how the micro-forecaster takes the basic micro forecasts (which are the subjects of papers by others) and derives the forecasts that are used for planning specific facilities. In that sense, the session title given in the program is a bit misleading, because we'll be looking at airline as well as general aviation terminal-area activities. A secondary purpose is to point out certain areas in which the forecaster would be aided by data that either he does not now have or he does have but about which he may not be fully confident.

BACKGROUND

As recently as six or seven years ago, sponsors of terminal-area facilities couldn't purchase and construct rapidly enough because growth rates of from 10 to 20 percent per annum had come to be regarded as the durable norm. We had to run just to keep in place. Under the circumstances, a few key forecasts, combined with dozens of rules of thumb and a few graphs or nomograms, were all that the planners, designers, and financiers of terminal-area facilities felt were necessary for the scaling and scheduling of multi-million-dollar construction projects.

Passing over the events of those past six or seven years, let it suffice for our present purpose to say that today's near-universal password in aviation circles is "economy of means." If a purchase or a capital improvement can be put off for a year or more without great detriment to one's enterprise, without significantly inconveniencing the public, and (most important) without compromising safety--well, by all means, making do with what you have is generally the sensible course to take. If you must invest, the need must first be clearly defined and adequately justified. (If you can land-bank for new, post-1990 airports in the meantime, then you're really going to be expected to watch the dollars

going into existing facilities.) In today's climate, therefore, projections derived by rules-of-thumb and out-dated nomograms from basic forecasts of annual activities are no longer acceptable.

The basic forecasts are generally considered to be annual forecasts of passengers, cargo, mail, and based general aviation aircraft by type. (For joint-use facilities, forecasts of military operations of various kinds are also basic.) Annual passengers may be originating only or originating-plus-terminating. Or, if justified by the nature of the data, total enplaning (or enplaning-plus-deplaning) passengers may be forecasted directly. Cargo is generally forecasted as tons of freight and express enplaned, or enplaned-plus-deplaned. The same is true for mail. Based aircraft are usually categorized as single-engine, one-to-three places; single-engine, four-or-more places; light twins, multi-engine heavy, turbine powered, and helicopter. One has to exercise care with overlaps in some of these categories.

DERIVATIVE MICRO FORECASTS--AIRLINES

There are two kinds of derivative forecasts that really matter to the public sponsor of an airport: (1) certain annual forecasts (e.g., annual airline aircraft departures); and (2) forecasts of activities during specific design-time intervals--such intervals can be as short as 10 or 15 minutes (as with baggage-claim facilities) or as long as a week (as with long-term parking facilities). The uses to which the basic and the derivative forecasts are (or can be) put are indicated in Figure 1.

There are a number of "bridge" assumptions that have to be made in working from the basic forecasts to the derivative forecasts. Nowhere is the forecaster more naked--the more explicit he is the more his judgment (or, perhaps, his bias) is placed in full view. He is in particular difficulty if he assumes that past relationships among various factors will change appreciably in "his" future. Figure 2 shows some of the more important assumptions that have to be addressed.

The factors entering into the derivation of forecasts of annual scheduled operations by the local-service, trunk, and international flag carriers are among the most controversial that the forecaster encounters. If the forecasts are going to be employed

in the master planning of a particular airport, and if that airport has been in existence for some time and by now has problems of crowding almost everywhere you turn, it's probably advisable to come straight to grips with the community's air service patterns so that each carrier's needs can be analyzed individually. That means you're going to get into some form of city-pair analysis.

The biggest advantage of a city-pair analysis that's been performed with reasonable diligence is that you're on good, high ground when the storm waves come at you from all sides. When used as a subject for a public workshop session, it's a superb educational tool for the layman who may never have heard of certificate authorities, routes and route segments, "beyond" points, turn-arounds, etc. You also end up with a picture of the future that everyone in the community can understand--the daily volume of operations in and out. In its most elementary form--which is most often all that's necessary--it can be placed in the simple tabular format illustrated in Figure 3. The format is simple; but the amount of work that has to be done before the table can be typed is considerable. One should never, however, lose sight of the purpose and overdo it. Basically you're trying to allocate approximately the right amount of space to everyone who needs it--you're not building a watch to tell the right time on one particular day in 1995.

In approaching such an analysis, one should first gain an understanding of the manner in which the community's airline service has grown in the past and of what the patterns are today. Generally speaking, the top 25 to 30 intercity markets will be found to generate from two-thirds to three-quarters (or more) of the total origin-destination traffic; so the job of data acquisition is manageable. New authorizations awarded to established carriers, the entry of new carriers, and carrier mergers are developments that generally (but not always) stimulate air travel. Sudden changes in the year-to-year origin-destination traffic reported for a given market are almost always indicative of a significant change in the pattern of service in that market.

One of the last steps in the process of familiarization is the preparation of a tabulation, like the one shown in Figure 3, of current non-stop services, with the carriers, the equipment, turn-around and through operations and the actual revenue seats identified for each market. Pick a peak-month schedule, if possible.

To get from past and current non-stop service patterns to the patterns that will be used for planning purposes, the forecaster has first to examine candidate markets for new non-stop services. (He may also have to investigate the possibility that some current non-stop service will be relinquished to third-level, or commuter, carriers.) It is here that his understanding of past patterns of growth in service inform his speculations. That understanding, combined with projections of intercity origin-destination volumes, should enable him to make reasonable projections of the markets that will have non-stop services in the landmark forecast years.

Incidentally, the kind of speculative effort that we're talking about used to be difficult enough. Today, with the specter of some kind of deregulation before us, it's a little like playing roulette. In my opinion, it's most prudent for now to ignore the forecasting implications of deregulation while paying more attention to the need for flexibility and expandability in the layout of passenger and cargo facilities.

Up to this point, the forecaster can be as explicit as he pleases in discussing his projections. However, he now must think about matters of carrier competition (unless, of course, the station is now a single-carrier station and is likely to continue to be a single-carrier station throughout the forecast period). In brief, who will be serving the non-stop markets, with what kinds of equipment, and at what frequencies? In approaching these questions, one should be familiar with:

- the overall route system of each carrier and the areas, if any, in which management is aggressively seeking to expand its authority

- the role of your station in each carrier's system--a station that may be an intermediate waypoint for one carrier may be an important hub in another carrier's system

- the plans (or general goals, if there are no firm plans) of each carrier for acquisition of new equipment and retirement of existing equipment

- the potential of providing non-stop services based in part upon "beyond" traffic.

Although they may never see the light of day outside of the forecaster's office, all assumptions made in the course of these speculations should be set down in meticulous detail before the synthesis typified by Figure 3 is attempted.

Perhaps the thorniest question of all is that of load factor. If the forecaster can get the cooperation of the carriers, he should if it's at all feasible have a count kept during the period covered by the schedule selected for analysis. The count should include both inbound and outbound passengers, classified as deplaning, enplaning, and through. (Never lose sight of the fact that the load factor includes the through passengers.)

Future load factors could easily be the subject of a conference of its own. On an average annual basis, a 55 percent segment load factor means that in most markets the would-be traveler can usually get a reservation on the same day as, or the day before, his flight. When the average annual load factor in a market gets to 60 percent or more, the inconveniences become noticeable. (The Chamber of Commerce gets restive, other carriers start eyeing the market--things like that.) Whatever the forecaster decides to use, he should have his rationale clearly formulated. His design-day factor will in any case be appreciably higher than the annual average.

Let's assume now that our forecaster has satisfactorily worked out his design-day forecasts. Since he has frequencies by equipment and by stage lengths, he's got a package to hand to the chap who analyzes future noise impact. He's also got an average design-day aircraft seating capacity, and this will seldom be much different from the average capacity for the year. If he has answered the questions of average annual connecting and through passenger ratios and segment load factors, he can now obtain his forecasts of annual airline aircraft departures.

Limitations of space preclude discussions of other annual carrier operators, if such are expected at the station. Data on intra-state and commuter activities at individual airports are hard to come by and often leave something to be desired in consistency of reporting, etc. The same is true for the activities of scheduled foreign-flag carriers, all-cargo carriers, U.S. and foreign supplementals, contract carriers, and small-package carriers. Most often, the forecaster has to start by subtracting the total of scheduled

domestic and U.S. flag operations from the total tower count of carrier operations and then try to apportion the result among the other kinds of carriers. Fortunately, some sponsors keep good records of such activities.

There are, of course, numerous other derivative annual forecasts besides airline aircraft operations. A list of the more important of them is given as Figure 4.

Returning to the design-day, the forecaster has next to develop forecasts for the various demands that the planners, architects, and engineers will have to accommodate. Figure 5 tabulates the more important of them. The basic forecasts and the key assumptions are combined to provide the "working" forecasts.

DERIVATIVE MICRO FORECASTS--GENERAL AVIATION

The Figures discussed under airline forecasting (with the exception of Figure 3) apply to general aviation as well as to air carrier aviation; so we have already seen in which areas key assumptions must be made and what the principal derivative forecasts are. By far the most important of them, particularly at airports used by air carriers, are the forecasts of annual itinerant and local operations; and this paper will conclude with a discussion of those two indicators.

Forecasts of annual itinerant and local demand can be made for a community or area with reasonable confidence under the following conditions (assuming the availability of a good basic forecast of locally-based aircraft):

- there will be no restraints on capacity
- the quality and scope of local fixed-base operations remain as they have been in the past
- there are no major changes in costs charged to aircraft owners and pilots
- nearby air service areas continue to be served as well (or as indifferently or poorly) as they have been in the past
- operations by large (air-carrier) aircraft are on the order of 10,000 per annum, or fewer
- the transient vs. local component of demand will remain constant or will change in a predictable manner.

In most cases, the best the forecaster can do is assume that local FBOs will continue to provide the same services that they have in the past, that peripheral competition will not change markedly, and that landing fees, fuel costs, and storage rentals will stay in scale with other cost-of-living increases. However, in some cases, known firm plans, such as the closing of a popular public-use, privately-owned airport, may have to be specifically taken into account.

There are two factors about which something is generally known that have a marked effect on annual general-aviation demand levels--capacity limitations and levels of air-carrier operations. From an admittedly limited amount of research, my conclusion is that relationships could be established (through further research) that would significantly assist

aviation forecasters, particularly those for whom a general-aviation forecast may be a once-in-a-very-great-while thing. Figure 6 illustrates my point. The graph is a general representation of a number of plots of general aviation itinerant operations, expressed as a percentage of air carrier operations (on the ordinate) vs. air carrier operations (on the abscissa). The data are as reported in FAA Air Traffic Activity.

As indicated, one can generally find three separable trend lines for the data points. Upon examination, the uppermost line will define fairly well the trend among airline airports of various sizes serving communities that have little or nothing in the way of general-aviation airports. The lowermost line represents the opposite situation--airline airports serving communities with ample general-aviation relievers, small fields, and strips. The middle line is an average of the data points for communities that are neither deprived nor liberally endowed with general aviation airports. Of considerable significance, I think, is the way that the curves tend to converge at both ends--the end of minimal air-carrier operations and the end of air carrier operations of 400 thousand or more.

It appears as though some fairly useful forecasting tools could be developed by further research in this area--tools that would enable the planners to investigate a greater number of possible futures in a given master plan or system plan.

On the subject of annual local operations at a particular airport, similar efforts have not been productive. Local activity is too much at the mercy of unpredictable local circumstances. The closing or relocation of a single fixed-base operation with a high reputation for student instruction can mean an overnight change of an order of magnitude in volume of local operations.

This has been borne out by plotting local operations, from year to year, as a function of carrier operations. There is neither rhyme nor reason to the plots one obtains for various airports; and my conclusion is that one would have to look at the totality of the local situation to make sense out of any of them. Perhaps a useful research project would be one designed to make the forecasting of a community's local operational demand a basic forecast--i.e., one dependent on population, income, prevalence of VFR weather, geographical

isolation, and the like. The master planner would then be able to see what contribution his facility could make to the satisfaction of the total community demand after taking care of itinerant demand.

CONCLUSION

Today's environmental and financial concerns dictate that we make the most of what we have and build, when build we can, with maximum economy. Forecasting's role in planning should be emphasized so that we can steer a way between the diseconomies of under-design on the one hand and of over-design on the other. Some improvements in data collection are warranted, as is some further research in certain areas involving general aviation.

FIGURE 1. SPONSORS' USES OF FORECASTS

	Basic	Derivative	
	Annual	Annual	Design-Period
Gauging facility requirements			✓
Supporting benefit-cost analyses	✓	✓	✓
Scheduling improvements			✓
Supporting financial master plans		✓	
Supporting non-sponsor developments			
• Access improvements		✓	✓
• Zoning and land-use planning		✓	✓
• Private sector investment	✓		
Estimating environmental impacts		✓	✓
Estimating socio-economic community impacts		✓	
Supporting airline service improvements	✓		

FIGURE 2. KEY ASSUMPTIONS

For Derivative Annual Forecasts

Sched. Cert. Rte. Air Carriers--Domestic & U.S. Flag

- Connecting passenger proportion
- Through passenger proportion
- Average departing load factor
- Average aircraft seating capacity
- Runway utilization

Other Commercial Carriers--Scheduled and Non-Scheduled, and Non-Scheduled Operations of Cert. Rte. Air Carriers

- Ratio of departing passengers to departing passengers of cert. rte. air carriers
- Average departing load factor
- Average aircraft seating capacity
- Runway utilization

General Aviation

- Itinerant operations per based aircraft, VFR and IFR
- Local operations per based aircraft
- Proportion of based to transient activity
- Runway utilization

Air Passengers

- Ratio of visitors to passengers
- On-airport spending, dollars per passenger/visitor
- Ratio of out-of-town air passengers to local air passengers
- Off-airport spending, dollars per out-of-town air passenger
- Modal split of passengers and visitors for surface transportation
- Per cent utilization of principal access routes
- Passenger/visitor use of parking facilities

Employment & Other Economic Impacts

- Ratios of on-airport employment to various indicators of airport activity
- Average wages of on-airport employees
- Per cent utilization of principal access routes
- Employee parking requirements
- Ratio of on-airport payroll to off-airport direct and indirect payroll
- Goods and services purchased locally, as a ratio of direct payroll or of some other indicator

Figure 2 cont'd.

For Deiivative Design-Period Forecasts

Sched. Cert. Rte. Air Carriers--Domestic & U.S. Flag

- Peak-month activity as per cent of annual activity
- Average-day (or design-day) activity as per cent of peak-month activity
- Design-period activity as per cent of average-day activity
- Average load factors during the design period
- Average aircraft seating capacity during the design period
- Time (or times) of occurrence of design-period activity, by carrier
- Runway utilization

Other Commercial Carriers--Scheduled and Non-Scheduled, and Non-Scheduled Operations of Cert. Rte. Air Carriers--and General Aviation

- Ratio of activities to activities of sched. cert. rte. air carriers during the latter's design period(s)
- Peak-month activity as per cent of annual activity
- Design-day activity as per cent of peak-month activity
- Design-period activity as per cent of design-day activity
- Times of occurrence of design-period activity
- Runway utilization during design period of cert. rte. air carriers

Air Passengers

- Ratio of visitors to passengers
- Times of maximum passenger/visitor flows--arriving, departing, and total
- Maximum arriving and maximum departing as per cent of total
- Number of checked bags per passenger

Vehicles

- Times of maximum flows--outbound and inbound--by passengers/visitors (by mode), delivery and service vehicles, and employees (by mode)
- Design-period modal split (if different from average annual)
- Average pick-up and drop-off curb times, by mode
- Per cent utilization of various parking options

FIGURE 3. HYPOTHETICAL DAILY DEPARTURES[1], 1985

First-Segment Destination[2]	Inter-City Mileage	Aircraft Equipment Class and Seats: (747) 380	(L-1011) (DC-10) 250		(7X7) (DC-X-200) 170	(DC-9-50) (727) 125		(DC-9-10, etc.) (737) 95		(CV 580) 50	Σ	
Turn-around or Through→		TH	TA	TH	--	TA	TH	TA	TH	TH	TA	TH
A	425	2	2	4	--	7	3	--	--	--	9	9
B	692	--	3	3	--	--	8	--	8	--	3	19
C	120	--	--	4	--	6	--	6	4	--	12	8
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
V	95	--	--	--	--	--	--	--	2	3	--	5
W	163	--	--	--	--	--	--	--	2	--	--	2
X	209	--	--	--	--	--	--	--	--	2	--	2
	Total	2	5	11	0	13	11	6	16	5	24	45

[1]Arrivals assumed in same numbers from same stations with same equipment.

[2]Same as last prior station for arrivals.

FIGURE 4. DERIVATIVE ANNUAL FORECASTS

- Airline aircraft operations
- Other commercial carrier operations
- Non-scheduled air-taxi passengers, operations
- General-aviation operations, itinerant (including runway-critical aircraft) and local, VFR & IFR
- Military operations, itinerant and local
- Instrument approaches, by operator type, by IFR Category
- Non-passenger visitors to passenger terminal areas
- On-airport employment
- Vehicles
  - Total, in and out
  - Revenue parking (short-term, regular, long-term and remote)
  - Rental car business volume
- Others, as appropriate to individual circumstances
  - Aviation fuel consumption
  - Aircraft sales
  - Paved area rented
  - Unimproved area rented
  - Building space rented

FIGURE 5. DEMAND FORECASTS FOR PLANNING AND DESIGN

Airspace

- Total terminal-area activity during design periods, for cert. rte. carriers and general aviation by ATC aircraft class, VFR and IFR, itinerant and local
- Airway (or airspace sector) utilization during design periods, inbound and outbound

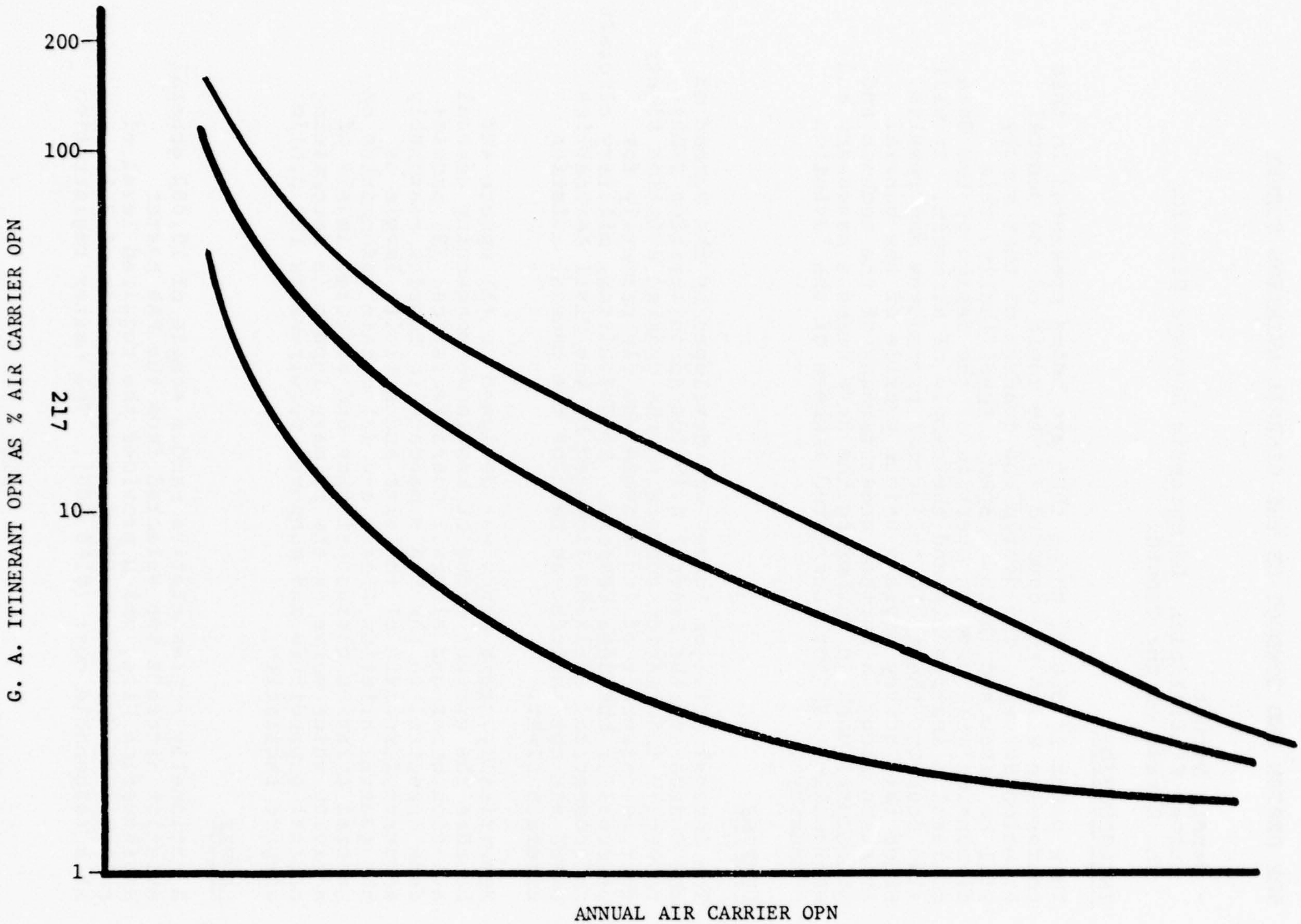
Airside

- Demand by runway during design periods for cert. rte. air carriers and general aviation, etc. (as above)
- Demand for taxiing routes during design periods, by ATC aircraft class, VFR and IFR, inbound and outbound

Landside

- Numbers of carrier gates, by carrier (or class of carriers) by aircraft size class
- Simultaneous occupancy of departure rooms
- Flow through security facilities
- Demand for ticketing and information services, by carrier
- Demand for baggage claim, by carrier
- Demand for general public space and amenities
- Patronage of concessions
- Demand for curb space at passenger terminal
- Inbound and outbound volumes of air cargo, by carrier
- Demand for truck docking positions at air cargo facilities
- Demand for general-aviation tie-down facilities, by aircraft size class
- Demand for conventional and T-hangar storage, by aircraft size class
- Aviation fuel storage requirements, total gallons by user and by fuel type
- Demand for parking facilities, by kind of facility
- Inbound and outbound flows at ticket-issuing and fee-collection stations of revenue parking facilities
- Vehicular flows, by principal vehicular classes, on each major segment of the airport's road way system and of its access network

FIGURE 6. GENERAL AVIATION OPERATIONS AS A FUNCTION OF CARRIER OPERATIONS



THE DESIGN AND CONDUCT OF THE GENERAL AVIATION SURVEY

- Dennis Stoudt
Survey Statistician, Demographic Surveys Division
The Bureau of the Census

INTRODUCTION

This paper is one of three that are being presented in this conference which are devoted to the topic of the General Aviation Survey. The design and conduct of that survey will be discussed in this paper. Specifically, this discussion will give an overview of the design of the data collection instruments and the sample of aircraft. It will also describe the field collection procedures and results. Since this survey gives a unique profile of the general aviation fleet, a further understanding of the methods and procedures used in gathering the data seems a necessary and worthwhile task for interested members of the "aviation community".

PURPOSE

The General Aviation Survey was developed by the Bureau of the Census and the Federal Aviation Administration (FAA) to obtain information concerning the general aviation fleet; that is, aircraft of individuals who fly primarily for personal or business reasons. By definition, military aircraft and commerical airlines licensed by the Civil Aeronautics Board are not included as part of the general aviation aircraft fleet.

Specifically, this study was designed to (1) update and broaden the current store of knowledge concerning general aviation owner and aircraft characteristics; (2) provide data essential to the FAA's mandate to furnish reasonably accurate forecasts of the size and activity levels of the general aviation fleet; and (3) obtain information on general aviation characteristics and expected levels of activity which serve as the primary inputs in determining capital expenditure and manpower requirements for public airport facilities.

SAMPLE

A nationally representative random sample of 10,002 general aviation aircraft was selected from the FAA Master Registration File, which provided the required level of reliability (with a coefficient of variation of 3.1) at a reasonable cost ($180,000). The master registration

file is a complete file of all aircraft registered in the United States. The aircraft were ordered by type, geographic region and so forth prior to sampling to ensure an equal opportunity for selection. Aircraft not in the general aviation fleet (e.g., commercial airliners), aircraft based outside the United States, non-engine propelled craft, and government-owed aircraft were excluded from sample resulting in a sample universe of 177,641 aircraft as of January 1975. Of the 10,002 sample cases selected, it was discovered that 142 cases were not currently registered in the name of an eligible aircraft owner. Therefore, 9,860 cases were actually sent to the field for interview.

For this survey, the primary respondent was the sample aircraft owner; however, if the owner was unavailable for the entire survey period (about 2 months), any knowledgeable person could respond (for example, a spouse, airport personnel, company representative, etc.). In fact, however, the use of proxy respondents was minimal.

FORMS

A questionnaire, interviewer's training memorandum, and "Introductory" letter were designed for use in the survey.

The questionnaire was affixed with a label containing sample aircraft and owner identifiers. Questions regarding the sample aircraft included its: capabilities, usage, activity, location, type and present physical condition. In addition, the sample aircraft owner's income, industry and occupation were determined.

The interviewers working on the FAA survey were given one and one-half hours to study the interviewing procedures memorandum and survey forms prior to the commencement of field work. The procedures memorandum was retained by the interviewers for reference purposes as necessary during their interviewing.

An "Introductory" letter explaining the survey and its purposes was sent to the sample aircraft owners approximately one week prior to the first field contacts.

INTERVIEWING

The survey, as originally conceived, was to be conducted in two phases. The first part of the field work was to be conducted entirely by telephone, with a sample of the telephone noninterviews being contacted by personal visit following the telephone phase. In fact, however, some follow-up interviews were also conducted by mail. The mail

follow-up was added because it offered an opportunity to increase the reliability of estimates made from the data at a very modest cost. Unlike most surveys conducted by the Census Bureau, interviews conducted by personal visit were not restricted to any specific geographic area but included cases from both within and outside current Census sample areas, which are called primary sampling units.

Telephone phase

Telephone interviewing began on July 1 and was completed on August 8, 1975. However, before telephone contacts could be made, the interviewers were required to obtain the telephone number of the sample aircraft owner. To accomplish this, all "leads" were followed, including: consulting local telephone directories containing the telephone information, visiting the post office to obtain a more current address, and/or visiting or telephoning the airport where the sample aircraft was hangared. During this period no personal visist contacts were attempted. Telephoning was done from the interviewer's home or from one of the Census Regional Offices, depending on the workload and staffing requirements of that office.

The results of the telephone interview phase were as follows:

	Number	Percent
Total Aircraft Selected in Sample	9860	100
Completed interviews	9271	94
Noninterviews	589	6
Refusals	108	1
Unable to contact	192	2
Other noninterview	289*	3

*200 of these persons had no listed telephone number

The response rate by the twelve national Census Regions varied from 99.7 percent to 86.8 percent before follow-up.

With an excellent overall response rate of 94 percent following the telephone phase of interviewing, several alternative tactics for completing the survey were discussed:

(1) Terminate the survey without conducting any personal visit follow-ups.

(2) Follow-up one-half of the telephone noninterview cases by personal visit.

(3) Follow-up one-third of the telephone noninterview cases by personal visit and the remaining two-thirds by mail.

Alternative "3" was selected as a compromise based on cost effectiveness and the achievement of data reliability. A personal visit follow-up was conducted to minimize any bias which might be caused by interviewing exclusively by telephone. That is, characteristics of persons without telephones might differ markedly from those with telephones and, therefore, the results obtained by interviewing solely by telephone might not adequately represent the entire universe of general aviation aircraft owners.

Personal Visit Phase

Interviewing by personal visit began on August 13 and was completed on August 29. The interviewers were instructed to follow-up on all "leads"--including contact with neighbors, the post office, airport personnel, and so forth--within a 50 mile (one-way) distance of the interviewer's home.

Of the 193 cases subsampled for personal visit, 94 or 49 percent were completed. The 99 noninterviews were distributed as follows: 23 or 12 percent refused, 32 or 16 percent could not be contacted, and the remaining 44 or 23 percent were "other" noninterviews.

In retrospect, the costs associated with obtaining a personal visit interview, as opposed to that of a telephone interview, appear to be large for the results obtained. That is to say, the cost of 94 personal visit interviews represented approximately 14 percent

of the total survey field costs, and increased the overall response rate for the survey by slightly less than 1 percent. From an operational point of view, attempting to balance costs with results, the use of personal visits in this survey appears to have been inefficient and relatively ineffective. However, an analysis of the results of the personal visit interviews to determine what, if any, bias would occur by not visiting a sample of telephone noninterviews personally is underway at present. The results of this analysis were not available at the time this report was prepared; thus, no evaluation of the anticipated bias of excluding this operation can be included in this report.

Mail Phase

Following the design of a revised "Introductory" letter explaining the survey and the method for completion, the remaining telephone noninterview cases were contacted by mail from Washington requesting that they complete the questionnaire by self-enumeration. Other than the few instructions included in the "Introductory" letter, no special instructions were provided for filling the questionnaire. Approximately 1 month was allowed for return of the completed form. Time did not allow for any follow-up of nonresponses to this mailing.

The questionnaires were sent to the respondents via certified mail, except to those persons residing in the Philadelphia, Detroit and Seattle (excluding Alaska) Census regions. Approximately 30 percent of those contacted responded to the mail inquiry. The response rate varied considerably by region, but no discernible difference was noted in the return rate of the certified compared to the regular mailings. That is, the results indicate that the use of certified mail obtained no greater (or lesser) response rate than did the use of regular mail.

The mail follow-up response rate of 30 percent is reasonable when one considers that all of the cases were originally noninterviews in the telephone phase, including refusals, that the survey period was limited to 1 month, and that no further follow-up was initiated. This survey method could be made more effective, while maintaining efficiency, by including a second mailing (reminder) to the nonrespondents. With a second mailing to nonrespondents a response rate equaling or exceeding that of the personal visit phase might be attained at a fraction of the cost.

CLERICAL PROCESSING

The completed forms were sent to the Census processing center in Jeffersonville, Indiana, for check-in and clerical processing. The clerical edit included verifying key items, industry and occupation coding (using standard 1970 codes), and recoding of "Other" entries for several questions.

COMPUTER PROCESSING

The computer processing was performed on the IBM 360 computer and included a consistency edit, weighting the file, and preparing tabulations.

1. Consistency Edit

   In the consistency edit, each data item was checked to determine if the entry was acceptable and, when necessary, corrections were made where possible or the item was blanked when no correction was possible. The ranges of acceptable entries for hours, trips and engines were developed jointly by FAA and Census staff members.

2. Weighting Program

   Each data record was assigned a basic weight which was the inverse of its probability of selection for the sample. This basic weight was then adjusted for nonresponse. The nonresponse adjustment was developed by grouping the interview and noninterview records by region and type of engine (12 cells) and then dividing the total sample cases by the completed cases resulting in a noninterview factor to be applied to the basic weight of each record in a particular cell. By this method, the amount of bias introduced by assigning the characteristics of interview cases to noninterviews was minimized.

3. Tabulation Package

   The tabulations for the FAA survey were basically weighted tallies for each item on the questionnaire. These tallies presented the absolute number of weighted response by answer category for each question and/or subpart of a question and the percentage response rate for each answer category. Industry and occupation categories were recoded to the 2-digit major industry and occupation detail for presentation. Median values were also provided for the activity levels.

RESULTS

The tallies and data file (tape) with some data suppressed or recoded to maintain confidentiality, including documentation and record layout, were forwarded to the FAA in early February.

Some of the more interesting findings regarding the 177,641 registered general aviation (GA) aircraft are as follows:

- o One-half of all aircraft are flown primarily for "personal reasons," such as vacations and personal enjoyment.
- o Eighty-seven percent have been flown less than 5,000 hours over the entire life of the aircraft.
- o Nearly three-fourths were flown less than 500 hours in 1974.
- o Almost one-half of all GA aircraft owners hangar their craft at the airport presently used primarily because of its "Convenience."
- o The greatest proportion (28 percent of GA aircraft owners) had an annual family income in the $15,000 to $24,999 range.

SUMMARY

Reviewing the excellent response rate (in excess of 96 percent) obtained by the General Aviation Survey and the completeness of the survey responses, from a surveyor's point of view, further and more refined surveys in this area of inquiry seem very feasible. This is especially true when one considers that the information was produced at a cost of just over $18 per case. Further analysis of these data made by the FAA will ultimately decide whether the original objectives have been met; however, the quantity, quality, and diversity of the information already available would appear to more than justify the design and conduct of the General Aviation Survey.

GENERAL AVIATION SURVEY

- Stephen Vahovich
Industry Economist, FAA

The General Aviation (GA) survey contains an almost overwhelming wealth of information, which makes my job of summarizing it difficult. The results are written up in detail in the document entitled "General Aviation: Aircraft, Owner & Utilization Characteristics." This document represents the completion of the first part of an ongoing AVP program to utilize the survey data. The objective was to provide aircraft owners and the public at large with general analyses and informational statistics on the state of GA. Later, I will touch on the focus of planned future research. My summary proceeds in terms of four themes, running from the general to the more specific.

Theme I deals with the image of GA:

> The classic image of GA as the weekend, one airport, "pure" pleasure sport is no longer relevant.

Figure 1 illustrates this theme by showing that the typical GA owner, including both individual and company owners of GA aircraft, flew almost 2 1/2 times as many itinerant hours as local hours--62.0 itinerant hours versus 25.9 local hours. For individual owners, who represent just over 65 percent of all owners, median itinerant hours were almost twice as great as their local hours--49.8 versus 25.8. For the typical company owner of GA aircraft, itinerant hours are almost four times as great as their local hours. These results suggest that there is a significant amount of intercity flying among both individual and company owners of GA aircraft.

Alternatively, Figure 2 breaks out the data by user category. Here we focus on a smaller subset--the personal user, commonly thought of in terms of the classic image. Even for personal users, representing slightly over 48 percent of all GA users, the survey data shows that their median itinerant hours are about 1 1/2 times as great as their number of local hours. Personal users have a median of 41.5 itinerant hours versus 29.7 local hours. These statistics suggest more of a

transportation function for individual owners and personal use GA flying, rather than the classic pleasure of flight experience. It suggests that the present image of GA is a maturing one--the day of the silk scarf and swashbuckling GA flying has passed. GA is now orientated toward intercity transportation. However, the highly individualistic nature of GA still is very strong. This is evident from Figure 2 in the form of wide variability in activity levels--hours flown--among the user groups. For example, within the business community, median local hours for business users are over six times as great as that for executive users--10.1 local hours for business users versus 1.6 hours for executive users. On the other hand, executive users median itinerant hours are about three times as great as that for business users. The differences grow greater as more dissimilar use categories are compared. For example, median itinerant hours for executive users are almost eight times as great as that for personal users--321.7 median itinerant hours for executive users versus 41.5 for personal users. Median local hours for personal users are over 18 times as great as that for executive users. Thus the diverse and highly individualistic nature of GA is made explicit in the survey results. This diversity exists whether we break out hours flown by type of aircraft, region, or other criteria. Further, even within each user group, type of aircraft, or regional category, GA owners do not exhibit a high degree of homogeneity, but rather retain highly individualistic use patterns. For example, standard deviations for total 1974 flying hours (and both local and itinerant flying hours) equal to--and, in extreme cases, over twice as great as--the average value within the category are not uncommon. One might well ask what is the usefullness of data associated with such large standard deviations. It is precisely this finding that attests to the extent of GA's highly individualistic nature. Further, this finding has important policy implications in that it suggests that broad based regulatory actions may be expected to impact on the diverse facets of GA in a multitude of different ways. The survey data is significant in that it provides a means for estimating the differential impact across user groups, class of aircraft owner, region, etc., of policy actions.

Theme II deals with the uniqueness of GA owners:

> GA income and population distributions differ from those for the total U.S. population.

Figure 3 shows the ordinal ranking of U.S. population median family incomes compared with those for GA aircraft owners by FAA region. Unfortunately, the available data--the 1970 Bureau of Census data and our 1974 survey data--do not permit comparison of absolute numbers. Assuming regions have not shifted rank positions in the intervening four years of data difference, an ordinal comparison is valid. This slide shows that although the Alaskan and Pacific Regions rank first and second in both income distributions, very little similarity exists elsewhere in the rankings. For example, whereas the New England and Central Regions rank last and next to last, respectively, for aircraft owners' income, they rank third and ninth in the U.S. income distribution. Conversely, whereas the Southern and Southwest Regions rank last and next to last, respectively, in the U.S. income distribution, they rank somewhere in the middle in the aircraft owner income spread. From these results it may be concluded that while some similarity exists in the geographical location of the highest income typical members of the U.S. population and the GA aircraft owner community, significant differences exist in the geographical distribution of the middle and lower income representatives of these respective groups.

Figure 4 illustrates the differences in the population distributions. Comparing the proportion of the aircraft owners with the proportion of the U.S. population in each FAA region shows some broad based similarities but it also shows that significant differences exist. That is, the Alaskan and Pacific Regions rank last and next to last, respectively, in the distribution of aircraft owners and, with the exception of a reversal in their relative ranks, they also rank as the two regions with the lowest percentage of the U.S. population. Similarities also exist at the upper end of the two population distributions. The Great Lakes Region, having the largest proportion of aircraft owners (19.0 percent), has the second highest proportion of the U.S. population (21.1 percent). The Southern Region is ranked third both in terms of the proportion of the aircraft owners (14.8 percent) and the proportion of the U.S. population (16.4 percent). However, noticeable differences occur at the upper end and the middle of these two population distributions. The Western Region, having the second highest proportion of aircraft owners (16.0 percent),

ranks fourth in the proportion of the U.S. population residing therein (11.2 percent). The Eastern Region, having the highest proportion of the U.S. population (23.0 percent), has the fifth highest proportion of aircraft owners (12.6 percent). While the latter two cases represent the most striking differences, comparisons of the remaining regions also show no further correspondence as to their relative ranks in their respective distributions. Thus, for the large majority of the regions, aircraft owner and U.S. population concentrations are considerably different. Although both distributions show a tendency to gravitate toward the East Coast, this tendency is more pronounced for the U.S. population than for aircraft owners. That is, while the Eastern, New England, Southern, and Great Lakes Regions jointly account for 66.1 percent of the U.S. population, they account for 50.3 percent of the aircraft owners. Further, as may be noted from the statistics presented above, the U.S. population distribution has somewhat larger percentage values than the aircraft owner distribution at its upper extreme and lower percentage values at its middle and its lower extreme. Thus, it may further be concluded that aircraft owners are more evenly distributed than the U.S. population across FAA regions.

Having established some broad perspectives in terms of the current image of GA and how GA owners compare with the total U.S. population, we can narrow the focus somewhat.

Theme III treats the "typical" case:

> What does the typical or representative GA aircraft owner look like?

Figure 5 shows that the typical GA aircraft owner is most likely to be an individual and not a company owner--slightly over 65 percent of the total GA fleet is owned by individuals and the remainder is owned by companies. It also shows that our typical owner is more likely to own a four or more seat single-engine piston aircraft than any other single type--slightly over 47 percent of the aircraft owners own this type of aircraft. The second most popular type of aircraft is the one-three seat piston aircraft, representing about 37 percent of the total fleet. These statements hold true, in the qualitative sense, whether we look at the individual or company owned fleets. However, one very distinct difference

between these fleets is the much larger proportional representation of turboprops and turbojets in the company owned fleet as compared to the individual owner fleet--5.2 percent versus 0.2 percent.

Figure 6 shows that our typical owner is most likely to use his aircraft for personal reasons--48.5 percent of all users specify personal purposes as their primary use. As may be expected, the percentage of personal users increases--to about 65 percent--for the individual owner fleet, but drops dramatically--to 17 percent--for company owner fleet. For company owners, the single most common reason for aircraft use is business purposes, accounting for almost 31 percent of company ownership usage.

Figure 7 shows the geographical distributions of aircraft owners across FAA regions. Here the size of the region reflects the proportion of owners residing in the region. So, for example, the Rocky Mountain Region with one of the largest land areas (581,927 square miles) is shrunken to reflect the small proportion of the GA owners (5.3 percent) residing in that region. This slide shows that GA owners are more or less concentrated in five FAA regions, and our typical owner is only slightly more likely to reside in the Great Lakes Region than any of the other four high concentration regions. That is, 19 percent of the owners reside in the Great Lakes Region, but this most popular region differs from the Western, Southern, Southwest, and Eastern Regions by no more than six percentage points.

Figure 8 shows that the typical GA owner is almost equally likely to have VHF communication capability as VOR--77.7 percent of the fleet is equipped with very high frequency communication equipment and 76.8 percent of the fleet is equipped with a very high frequency OMNI-directional receiver. Further these are by far the two most popular types of avionics. The next most popular avionics device is the automatic direction finder--42.4 percent of the fleet is ADF equipped--followed by instrument landing system capability--36.6 percent equipage rate.

Figure 9 shows that the typical individual owner's occupation is more likely to fall into the Professional, Technical & Kindred category than any other--41.8 percent of all individual owners fall into this occupational category. This includes physicians, dentists, teachers, engineers, and other professionals. The second most popular occupation among individual owners is the Manager/Administrator category--30.5 percent of the owners fall into this occupational grouping.

Figure 10 we have seen before. It shows the hours flown for the typical GA owner. However, it also illustrates another important point--i.e., the importance of company ownership in GA should not be underrated. As pointed out, only about 35 percent of the GA fleet is owned by companies. Despite this fact the typical company owner flew almost twice as many total hours during 1974 as his individual owner counterpart--187.8 hours versus 105.4 hours, about twice as many itinerant hours--97.1 versus 49.8 hours, and about twice as many visual hours--96.9 versus 50.2, while flying approximately the same number of local and instrument hours.

The foregoing discussion again illustrates the diversity that exists in GA. This raises the key question: What factors account for or can be used to explain this diversity? Providing an answer to this question is the focus of ongoing AVP research.

The theme for this research, as well as the final theme of this summary is that socioeconomic and demographic factors influence hours flown, type of aircraft owned, and other ownership characteristics.

For example, Figure 11 shows that family income for the typical GA owner is about $24,000. But it varies from a low of $18,786 to $150,000. Looking only at the fixed wing aircraft some patterns emerge--income increases continuously from $19,653 for the smallest fixed wing aircraft to $150,000 for turbojet owners. The exception is the multi-engine pistons over 12,500 lbs.--a peculiar class composed of old air carrier aircraft. This suggests that family income and type of aircraft ownership are positively related. Although this relationship seems intuitively obvious, estimating the degree of that impact is no trival task. Estimating the impact of socioeconomic and demographic factors (e.g., income, region of residence, occupation) on such ownership characteristics as quantity and type of hours flown, ownership by type of

aircraft, etc., is the focus of this additional research.

Figure 12 illustrates another emphasis for further research. This slide suggests that there is a positive relationship between avionics equipage and type of aircraft owned. For example, 54.8 percent of the one-three seat single-engine pistons are VHF equipped, this equipage rate increasing to 91.5 percent for the four or more seat pistons, to 96.2 percent for twin engine pistons, and almost total equipage for turboprops and turbojets. Of course, more detailed research may show that income levels or some other characteristic is a better predictor of equipage rates. The potential applications for research in this area are very great. For example, estimating the demand for avionics as a function of aircraft owner characteristics has obvious marketing analysis implications. On the other hand, a problem may be formulated where the type and number of hours flown are expressed as a function of avionics equipage. Estimating the effect of avionics equipage on hours by type of flying would enable the FAA to evaluate the effect on activity levels of any policy proposal that varied avionics requirements--say for controlled airspace. Such analysis could be performed on a regional basis.

This is the type of research and practical problem solving that is envisioned for later studies.

FIGURE 2

MEDIAN FLIGHT HOURS BY TYPE OF OWNER

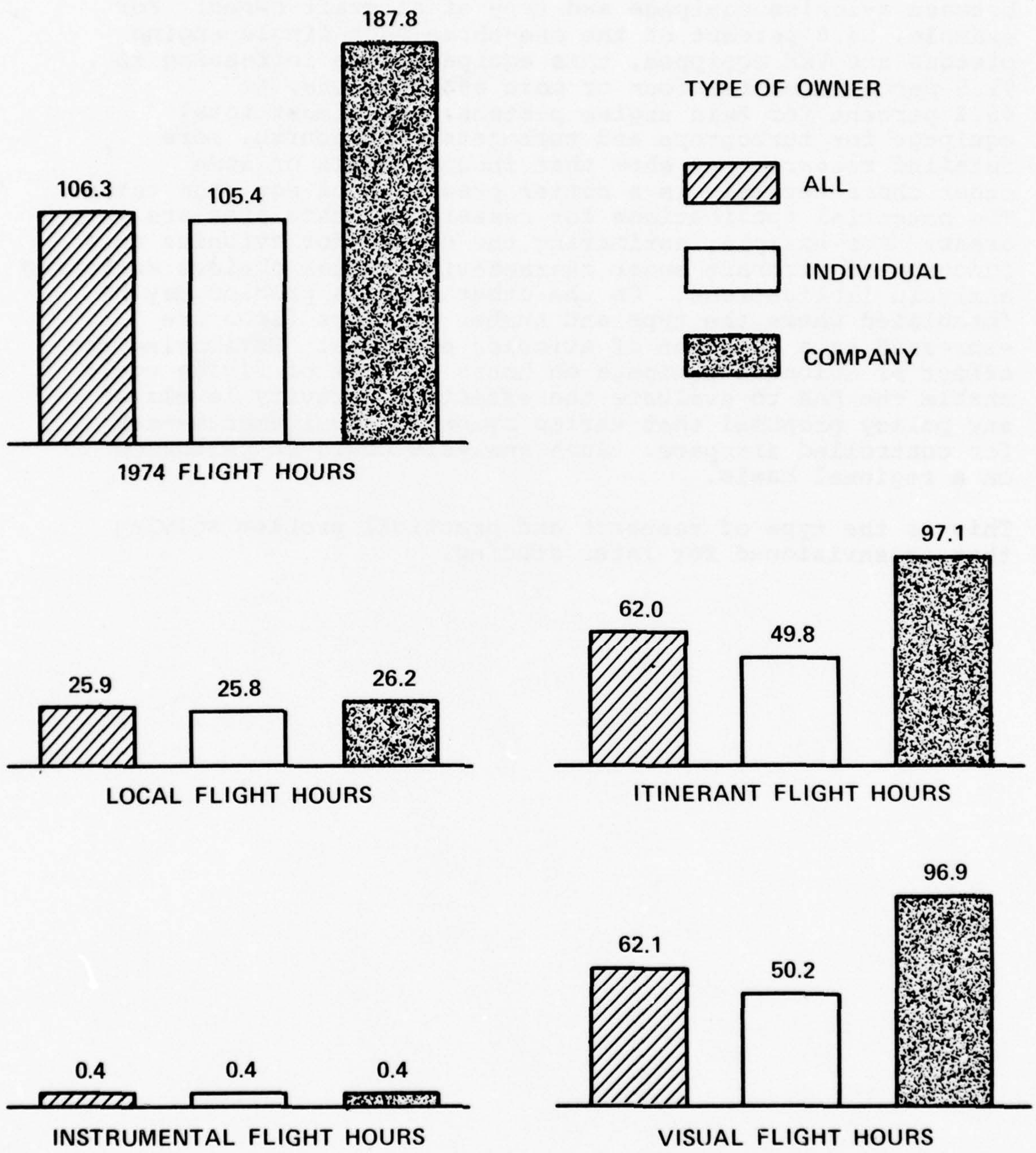
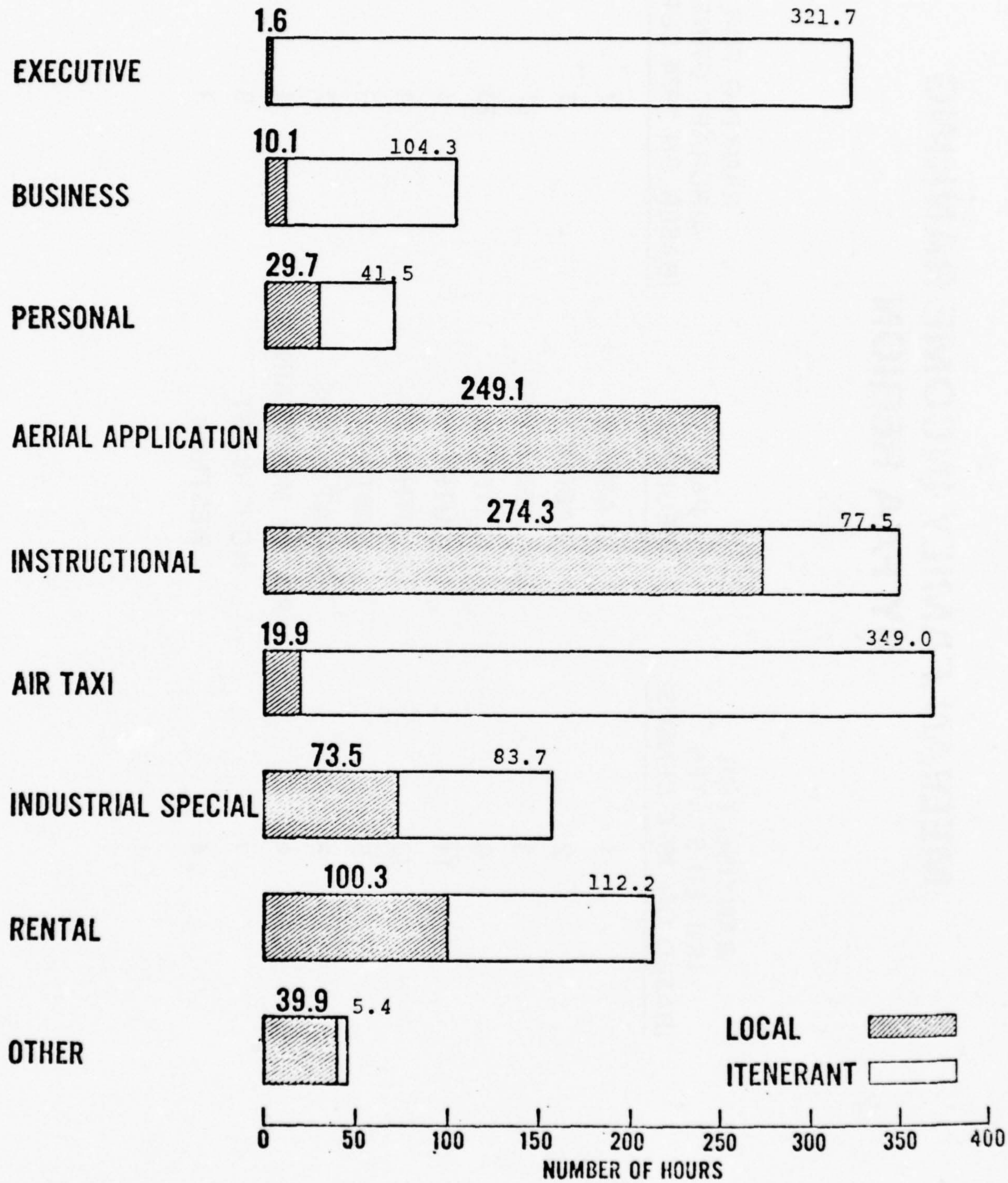


FIGURE 2

MEDIAN NUMBER OF FLIGHT HOURS BY PRIMARY USE OF AIRCRAFT



MEDIAN FAMILY INCOME RANKING BY FAA REGION

RANKING FOR UNITED STATES (BASED ON 1970 CENSUS)	FAA REGIONS	RANKING FOR AIRCRAFT OWNER (BASED ON 1974 SURVEY)
1	ALASKAN	2
2	PACIFIC	1
3	NEW ENGLAND	11
9	CENTRAL	10
11	SOUTHERN	6
10	SOUTHWEST	4
6	EASTERN	5
5	GREAT LAKES	7
8	ROCKY MOUNTAIN	9
7	NORTHWEST	8
4	WESTERN	3

FIGURE 4

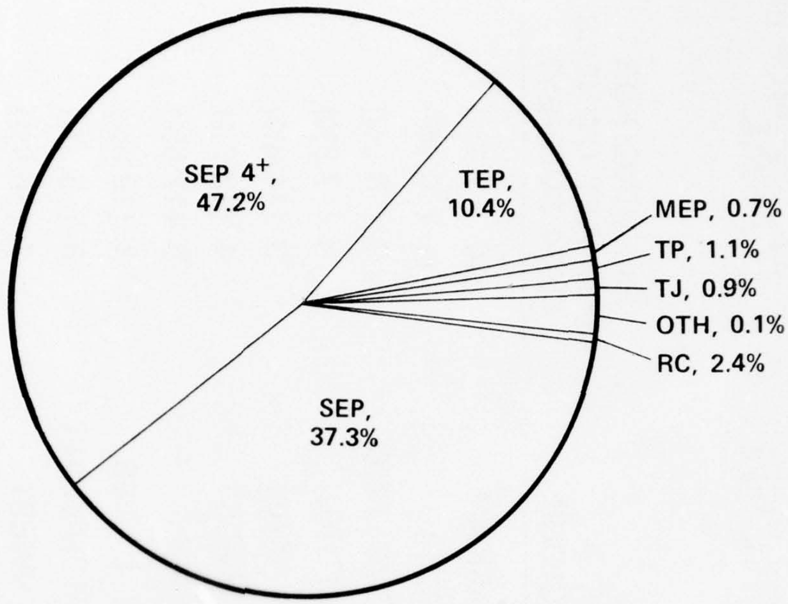
GA OWNERS VERSUS TOTAL U.S. POPULATION: RANKING BY PERCENT OF TOTAL*

RANKING FOR UNITED STATES (1975 BUREAU OF CENSUS ESTIMATES)	FAA REGIONS	RANKING FOR AIRCRAFT OWNERS (1974 SURVEY)
11 (0.1%)	ALASKAN	10 (2.1%)
10 (0.4%)	PACIFIC	11 (0.2%)
6 (5.6%)	NEW ENGLAND	9 (3.9%)
7 (5.4%)	CENTRAL	6 (7.5%)
3 (16.4%)	SOUTHERN	3 (14.8%)
5 (10.3%)	SOUTHWEST	4 (12.9%)
1 (23.0%)	EASTERN	5 (12.6%)
2 (21.1%)	GREAT LAKES	1 (19.0%)
9 (2.9%)	ROCKY MOUNTAIN	8 (5.3%)
8 (3.1%)	NORTHWEST	7 (5.8%)
4 (11.2%)	WESTERN	2 (16.0%)

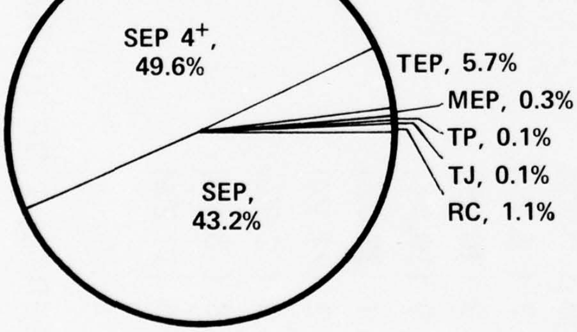
*( ) = PERCENT OF TOTAL

FIGURE 5

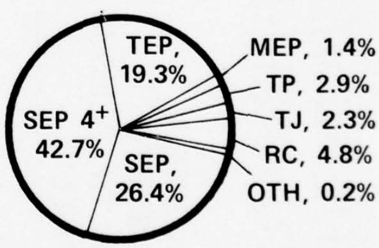
PERCENT DISTRIBUTION OF AIRCRAFT BY TYPE OF OWNER



172,496
TOTAL AIRCRAFT



112,241
AIRCRAFT OWNED BY INDIVIDUALS



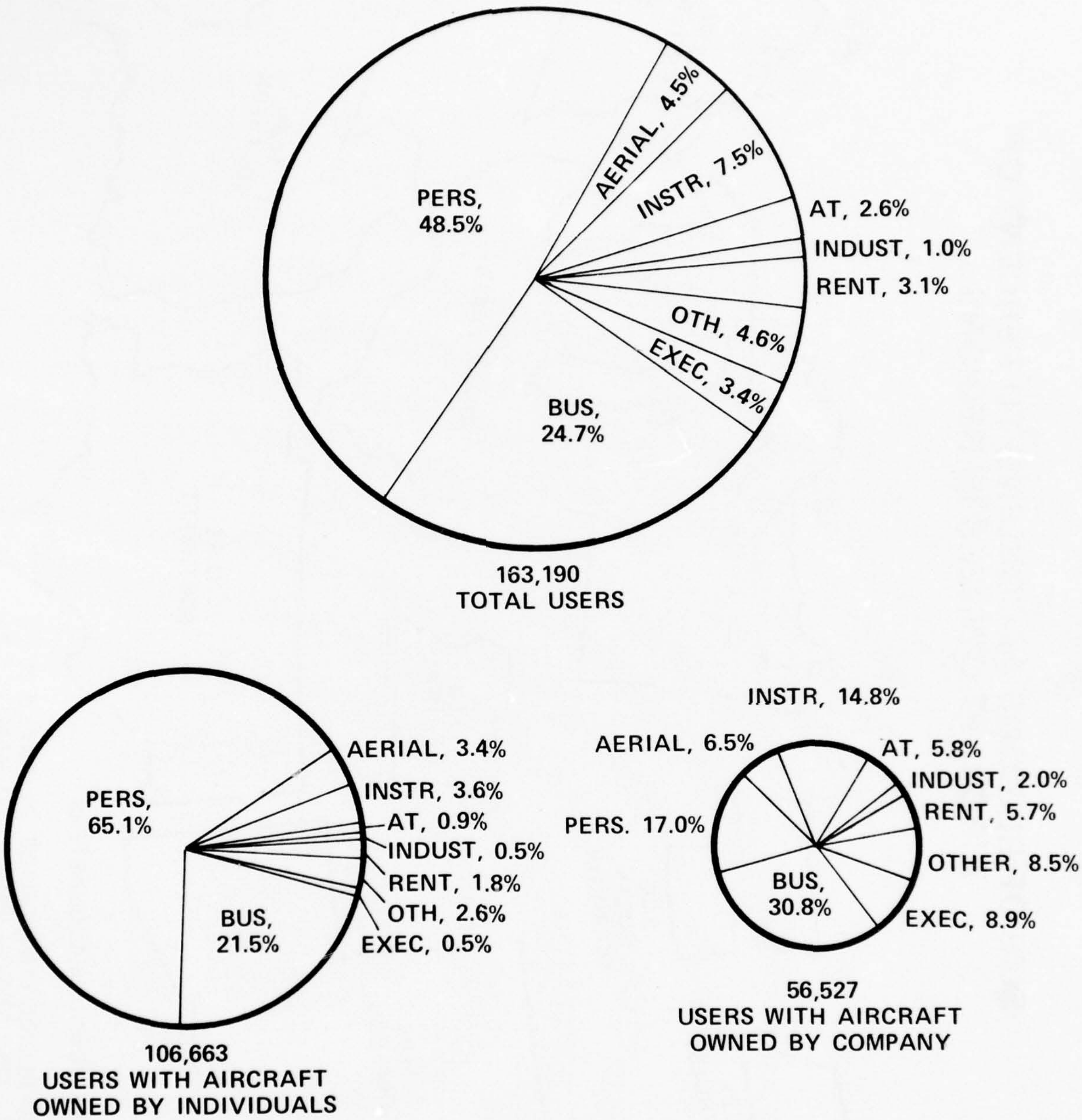
60,256
AIRCRAFT OWNED BY COMPANIES

LEGEND:

SEP – SINGLE-ENGINE PISTON (1 - 3 SEATS)
SEP 4+ – SINGLE-ENGINE PISTON (4 OR MORE SEATS)
TEP – TWIN-ENGINE PISTON (UNDER 12,500 LBS.)
MEP – TWIN- OR MULTI-ENGINE PISTON (12,500 LBS. AND OVER)
TP – TURBOPROP
TJ – TURBOJET
RC – ROTORCRAFT
OTH – OTHER

FIGURE C

PERCENT DISTRIBUTION OF USER GROUPS BY TYPE OF OWNER

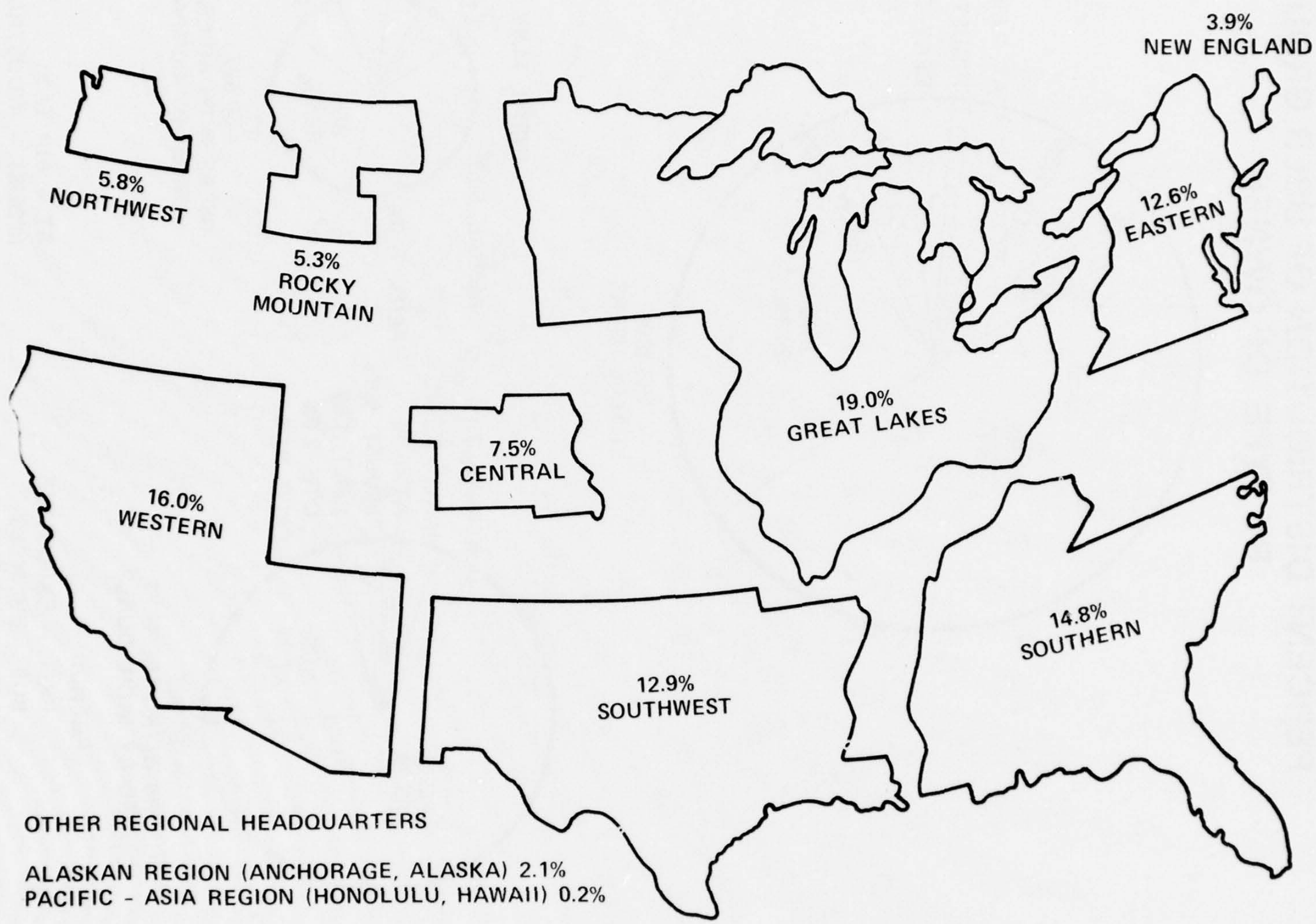


LEGEND:

EXEC – EXECUTIVE
BUS – BUSINESS
PERS – PERSONAL
AERIAL – AERIAL APPLICATION
INSTR – INSTRUCTIONAL
AT – AIR TAXI
INDUST – INDUSTRIAL
RENT – RENTAL
OTH – OTHER

FIGURE 7

SIZE OF REGIONS ACCORDING TO PERCENT OF AIRCRAFT OWNERS IN REGIONS

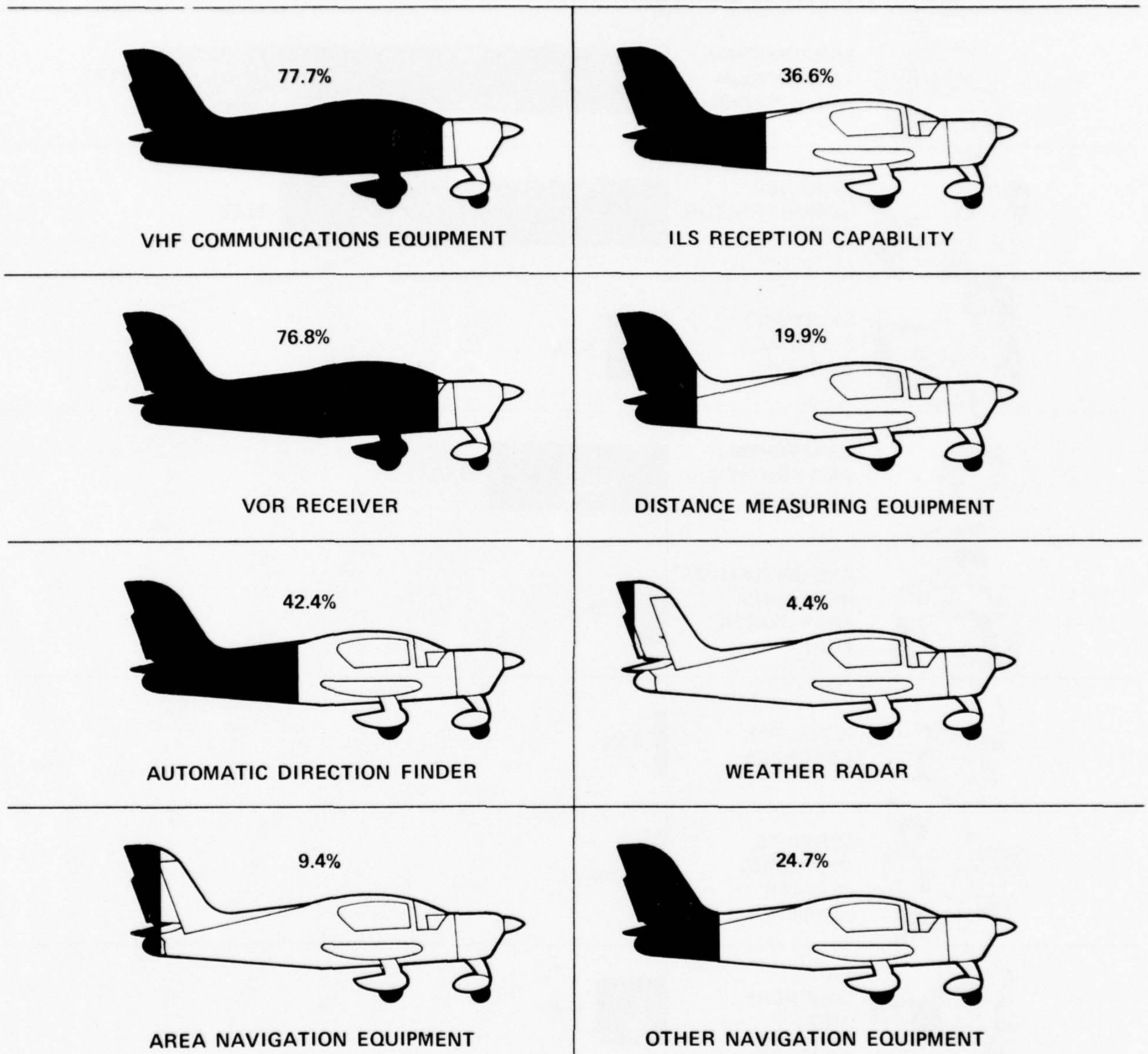


OTHER REGIONAL HEADQUARTERS

ALASKAN REGION (ANCHORAGE, ALASKA) 2.1%
PACIFIC - ASIA REGION (HONOLULU, HAWAII) 0.2%

FIGURE 8

PERCENTAGE OF GA FLEET EQUIPPED WITH AVIONICS



FIGURE

PERCENT DISTRIBUTION OF AIRCRAFT OWNED BY INDIVIDUALS AMONG OCCUPATIONS

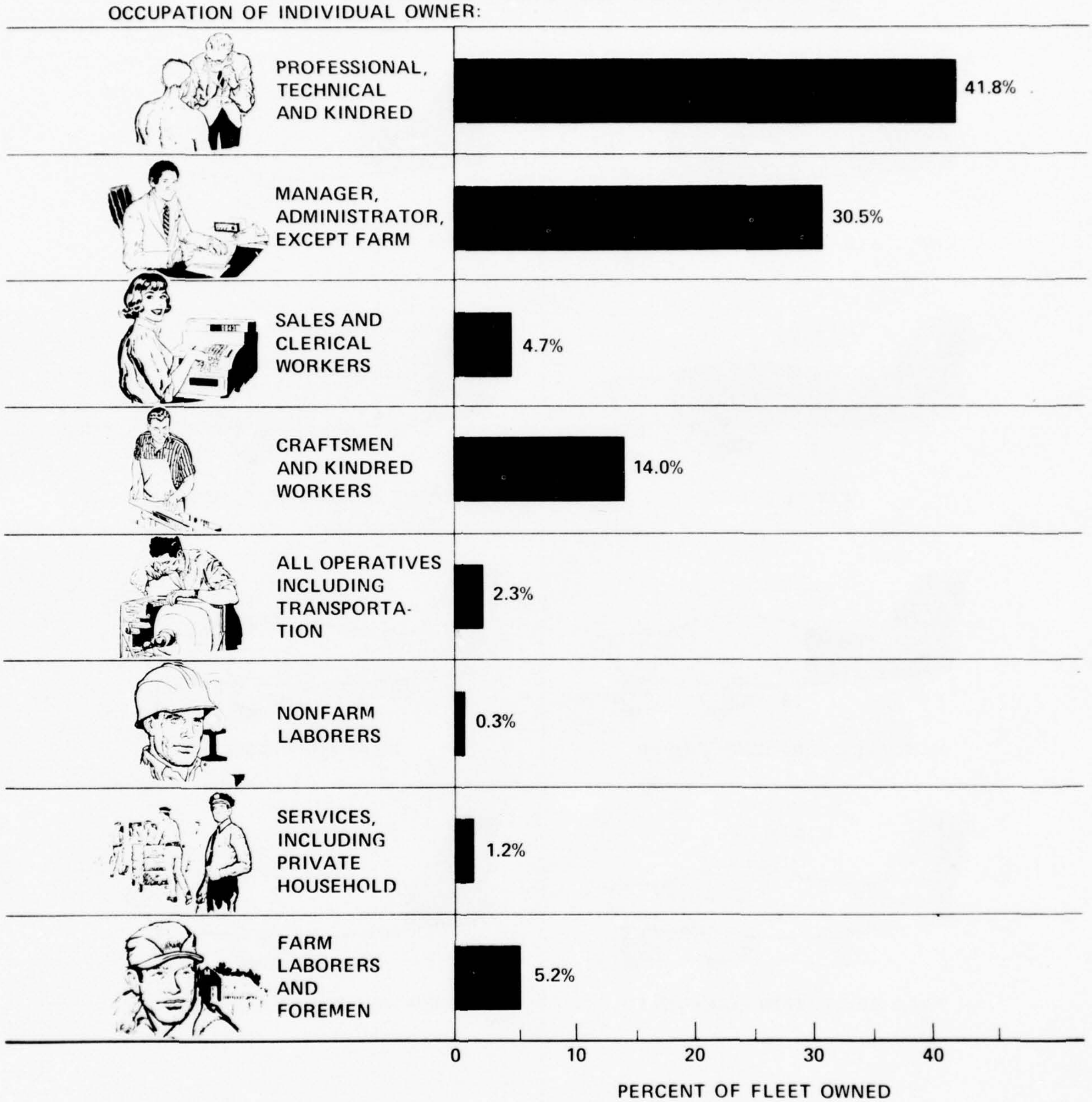


FIGURE 10

MEDIAN FLIGHT HOURS BY TYPE OF OWNER

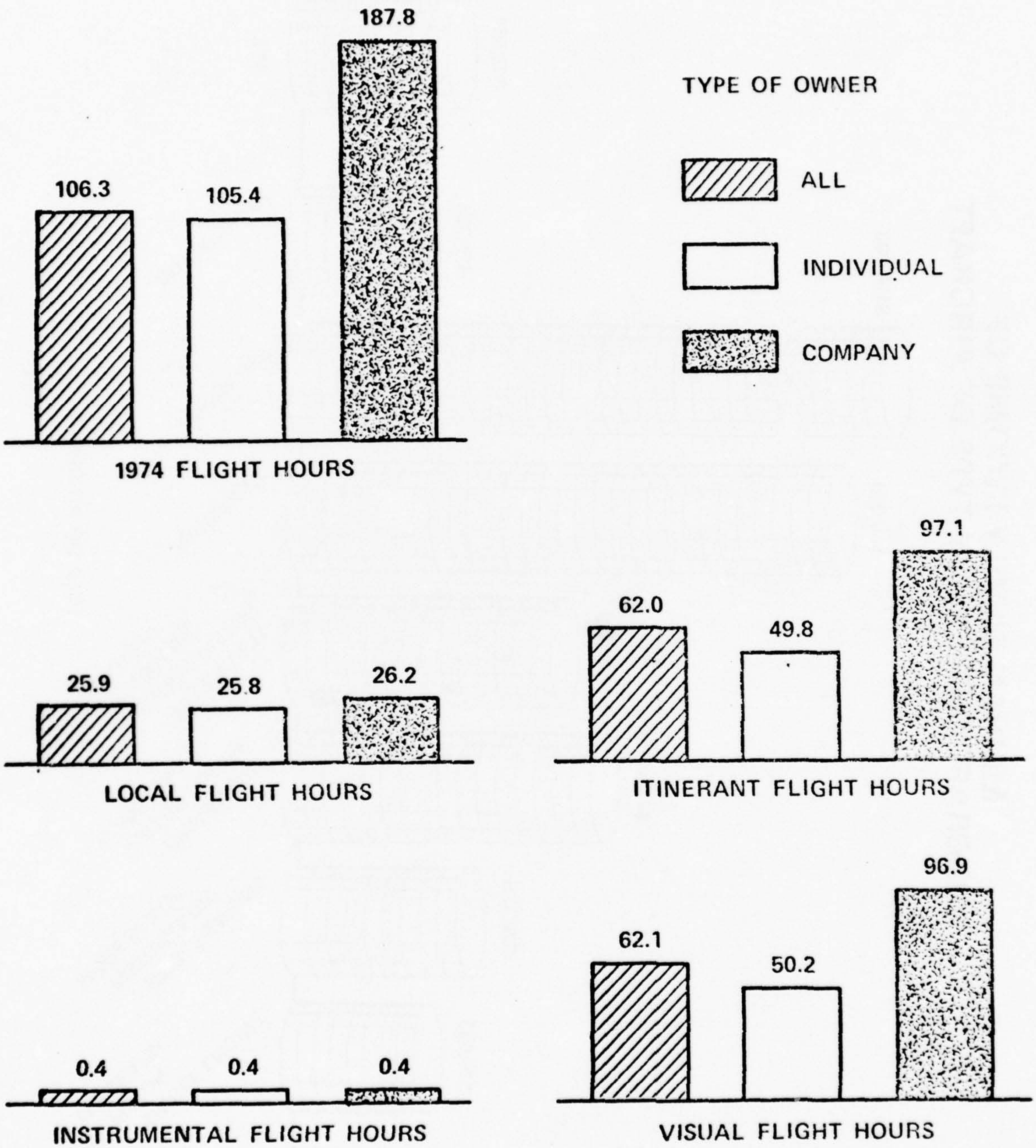


FIGURE 11

MEDIAN FAMILY INCOME OF AIRCRAFT OWNERS BY TYPE OF AIRCRAFT

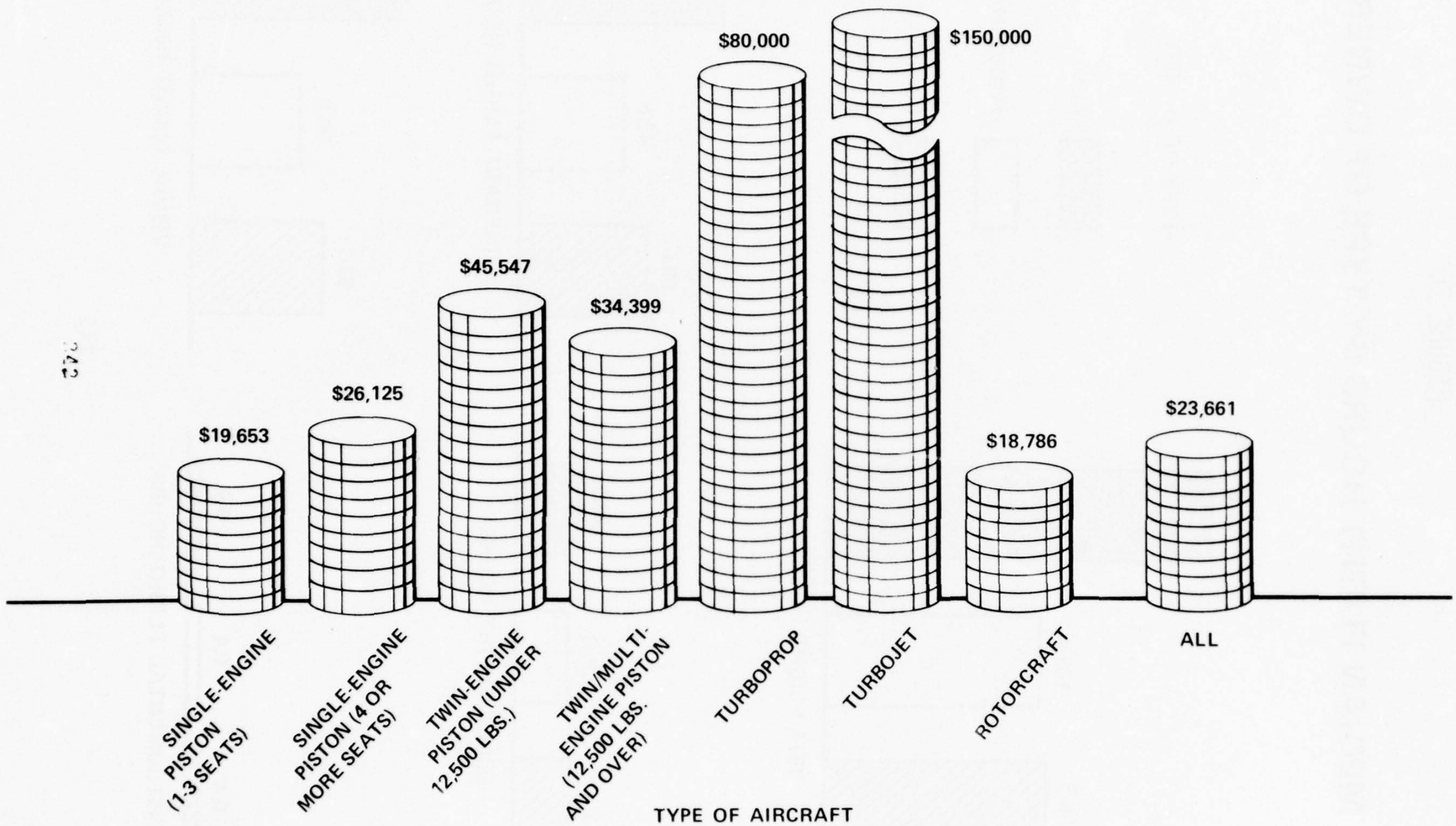
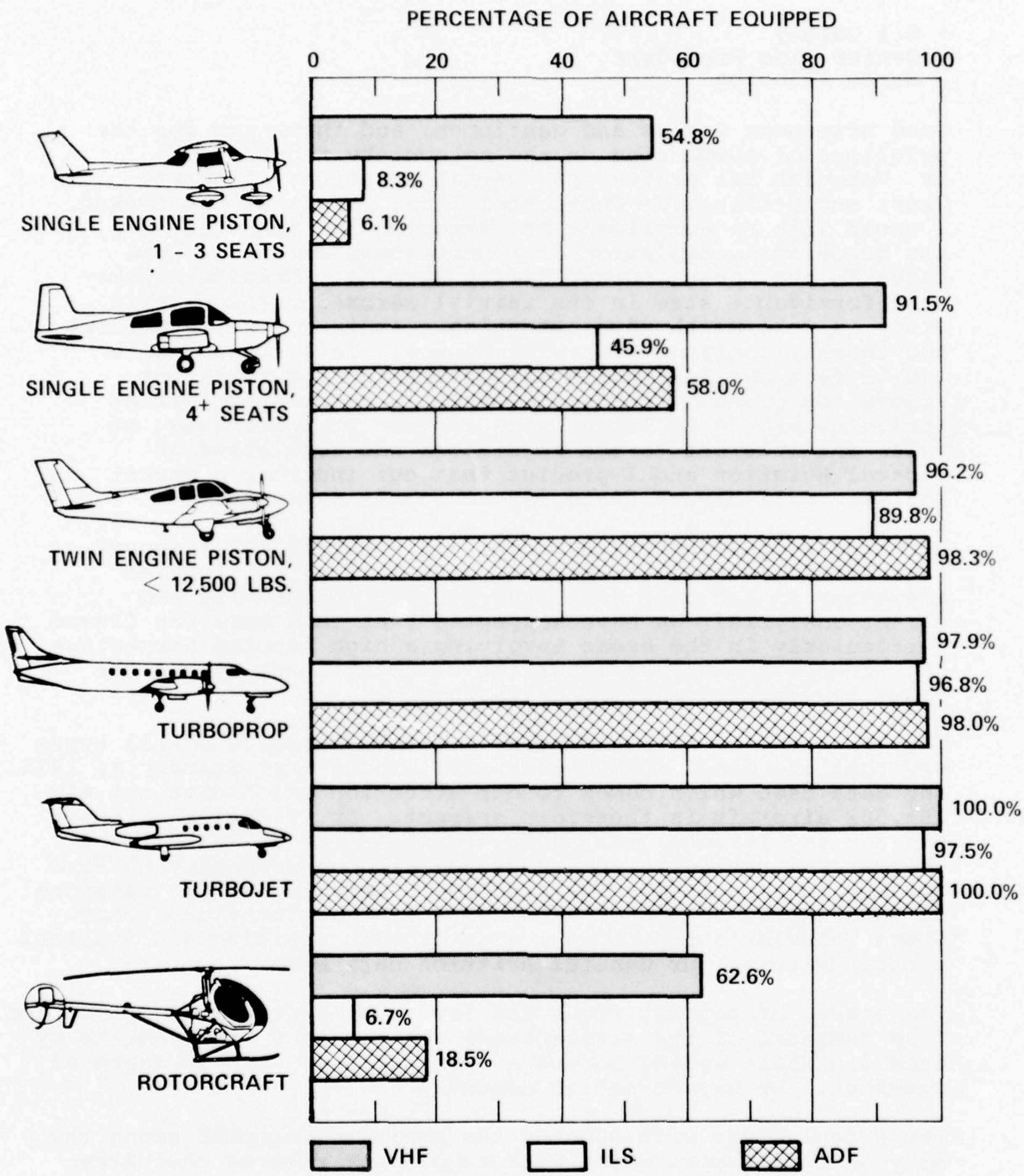


FIGURE 12

PERCENTAGE OF AIRCRAFT EQUIPPED WITH AVIONICS



COMMENTS ON FAA/CENSUS SURVEY REPORT "GENERAL AVIATION: AIRCRAFT, OWNER AND UTILIZATION CHARACTERISTICS"

- Gil Quinby
Senior Vice President
Narco Avionics

Good afternoon ladies and gentlemen, and thank you for the privilege of commenting on the noteworthy report that Dr. Vahovich has drafted on General Aviation: Aircraft Owner and Utilization Characteristics. Right at the outset, I would like to compliment Dr. Vahovich and his staff for the successful completion of a tremendous amount of work based on the Census Bureau Survey Records. Despite a somewhat formidable size in its initial xeroxed version, this study is well worth your attention. It is not without flaws and thereby confirms its independence. It's crammed with detail data and text which may be difficult reading for anyone not given a serious interest in demographic market analysis, but it is loaded with nuggets of information of value and interest to the regulators and regulatees in General Aviation and I predict that our industry's market analysts will have a field day among its matrices.

For many years, General Aviation has accepted FAA's annual Aircraft Registration Tapes and Data derived and imputed therefrom as the best data base for our forecasting and market analysis. We have suspected that this base was flawed particularly in the areas involving a high imputed percentage, but it was the only base available and at least it had the value of year-to-year trend consistency.

The FAA tapes of Active General Aviation Aircraft of all types say that the fleet numbered 161,502 aircraft at January 1, 1975. Any data base which comes to our attention which does not say 161,502 aircraft is therefore suspect. Dr. Vahovich's report did not say 161,502, but having committed to an analysis of the work, I dutifully undertook the digging necessary to find out how to account for the difference between the two versions of what should be the same number. I am now convinced that Steve Vahovich's report is a significant, positive and fruitful contribution to our General Aviation data base.

There are, of course, flaws and the usual statistical mousetraps. I am reminded of the statistician who met an untimely death by drowning while wading across a river with an average depth of one-foot. Or was it median depth?

Let's deal first with some of the positive examples among the many in this report which will supplement remarks that Steve himself has made.

First, and probably most important is correlation. If you dig deep enough this report correlates in many ways with the FAA tapes and with the Civil Air Patrol activity census. I cannot say that it correlates in every case, because I have dug into some cases which I could not correlate. And there are many, many cases which I did not process. My computer capacity is here in my pocket. Examples of correlation are encouraging and include the following:

1. Total rotorcraft on register according to FAA tapes is 3,610. According to the independent census survey it is 3,724.

2. The report of active aircraft off the tapes finds 73,878 single-engined aircraft in personal use. The census report makes the number 76,460 a 3 1/2 percent discrepancy.

3. Piston twin-engined aircraft in business service had to be subjected to a little imaginative factoring but with some logic the classic number of 7,733 can be matched with a census total of 7,670.

And so on. I conclude to my satisfaction that the degree to which the Vahovich Report correlates with the tapes and the Civil Air Patrol numbers offers valuable improvement in the confidence which we can assign to those numbers thus correlated.

The report further confirms our suspicion that the overwhelming mission of General Aviation is transportation. Vahovich wisely eschews the use of the terms "recreational" flying and segregates flight operations into local and itinerant hours. It is easy to convince listeners that the relatively small number of turbine-powered business aircraft are used for a predominately transportation mission. It should now be equally easy to prove that even the 48,000 personal-use small single-engined airplanes in the fleet are used somewhat over 60 percent of their flight time for transportation purposes. Note that the report does not get faked off into the question of why the transportation was performed; only that transportation did indeed occur. The average individual owning a single-engined aircraft for personal reasons made eight-trips in 1974 which averaged 200-miles one way in length.

While the transportation mission clearly dominates the use of General Aviation airplanes, the non-transportation mission is equally important in its statistics and infinite variety. Nearly 40 percent of the personal use of single-engined aircraft is in a local category, returning to the same airport from which it departed. While instructional flying is another

separate category, it is clear that much of this personal local flying is for the maintenance of pilot proficiency. It is also for the sheer sport of boring holes in a cloudless Sunday sky. And sight-seeing and acrobatics and parachute jumping and so on and on. Vahovich uses an excellent term; flying for "the pleasure of the flight experience." And over 5,000 large and small single-engined airplanes are in uses other than those carefully categorized in the survey. We might be most productively educated if we could find out what some of those other uses are.

In the occupation and family income categorization of individual owners it was no surprise to find that 72 percent of these individuals are in the professional, managerial or equivalent occupations. But 28 percent of the owners are in clerical, crafts and service positions with relatively low family incomes. The median income for the owners of 48,000 small single-engined personal use airplanes is $19,600, meaning that 24,000 of these aircraft are operated by families with less than this total income in 1974. Contrary to common conceptions, our industry has a significant "blue-collar" ownership.

Vahovich confirms the NBAA assertion that some 45,000 aircraft in the fleet are used for executive and business flying.

The report further establishes some interesting vintages by use category (Figure 3-4). They find that executive and rental aircraft are generally predominately new aircraft, while the older aircraft in the fleet are in personal and industrial service. (I was pleased at the caution displayed by the Census Bureau in picking the oldest age bracket as "manufactured between 1901 and 1959." We will not be caught napping if someone beat the Wright Brothers to it).

It would be irresponsible of me to limit this commentary only to the positive and worthwhile examples in Steve's report. There are flaws in both the source data collection process and the analytical process. I'm sure many flaws went undetected even in my double study. But here in a constructive sense are some areas that I would hope could be corrected before final publication or fuzzed out this time and corrected at the next opportunity.

The demographic analysis of aircraft ownership is related simplistically to population and other first order phenomena. Perhaps from the questionnaires or other sources unique regional needs for General Aviation service could be identified including the quality of alternate modes and the impact of natural and regulatory and economic constraints.

The amount of instrument flight operations in the General Aviation Fleet appears understated, even though it is undoubtedly correct in the analysis. And this understatement is fine with us for cost allocation purposes. Please send a copy to the Office of the Secretary of Transportation at your earliest convenience.

But for a more meaningful statement of General Aviation's use of Instrument Flight Rules and its capability to perform in the Air Traffic Control Systems, it would be better to assess instrument flight experience by flight hours or other exposure in type, rather than by simple numbers of airplanes in inventory.

It should be possible to simplify the reconciliation and correlation of the tables in this report with other familiar tables, ostensibly stating the same phenomena. From a universe of 177,641 total General Aviation airplanes in 1974, the matrix of total airplanes by function and owner totals 172,496. The matrix of function by type totals 163,190 and is closest to the classic type-mission matrix that we are accustomed to. It should not be necessary for the reader to dig into these differences to determine to his satisfaction whether they are significant or simply within the statistical averages that can be expected from this kind of work.

Having some familiarity with the business of avionics capabilities in the General Aviation Fleet, I was disappointed that the questionnaire was flawed in this vital regard. Transponders were overlooked in spite of the fact that respondents forced them into the only category available. Altitude Encoders were ignored completely, although 1974 may have been a bit early for this program to have attained significance. Similarly with ELT's. And even after several readings, I am not still clear as to what the analyst thought he had with response to the question about ILS capability. In one case, the report says that any ILS component meant a yes answer to the ILS capability question. But essentially all VOR receivers have an ILS Localizer capability. Perhaps this can be corrected by a finer definition of terms.

Many of the airplanes in our active fleet, particularly the new ones are owned and operated by and for the thousands of independent aviation service businessmen-the fixed base operators which Larry Burian told us about earlier this afternoon. Yet nowhere in this report is it possible to do more than infer the impact of this vital business segment

on the characteristics of the fleet. Maybe the FBO is buried in the type of business or company ownership of aircraft; certainly they show in the industrial and rental utilization categories and it might be possible to filter them out of the table of numbers of aircraft owned by single companies and individuals.

Finally, I am suspicious of the conclusions of the report regarding the median cruising speeds of our small aircraft. The slowest maximum recommended cruising speed in Cessna's 1976 product line is 120 miles per hour, on a standard Model 150. The lowly Skyhawk comes on at a respectable 138 according to the brochure and it goes on up from there. The high performance singles (over 200-horsepower or with retractable landing gear) all record cruising speeds in excess of 150-miles per hour. Granted, these are manufacturers figures on new airplanes subject to some optimism and degradation. But the rule of thumb I use on the tired old Piper Arrow I am occasionally privileged to operate, is 138-knots cruise at normal altitudes with 75 percent power, 120-knots (138-miles per hour) for block to block trip planning in unknown winds. Granted there are lots of old rag-wing airplanes that cannot make a block to block time of 100-miles per hour in transportation service. We may be faced with the median of the whole inventory including those airplanes that were not flown. This should be re-examined.

And finally there are the nits of interest which I cannot resist picking. The median speed of "other" airplanes is 207.7 miles per hour. The Arrows in Figure 2.1 for other and rotorcraft are reversed. In Table 6.3 I am amused that nearly 10,000 company-owned aircraft have personal use as their principal purpose. Someone should figure out why such a high percentage of flight activity in the Rocky Mountain Region is local.

But like I said, there is gold in all that report. I think the most important conclusions I would draw are the following:

1. We have increased the confidence with which we can use those parts of the analysis of registration tapes which are correlated by this sample.

2. We have a whole wealth of new information with which to undertake further cross check and correlation. Where correlation is not obvious, it will usually be fruitful and informative to determine why.

3. Careful study of this report will tell us more about the factors which motivate individuals to learn to fly, to use airplanes, to buy airplanes, and to equip airplanes. Properly analyzed we should be able to identify and perhaps correct counter-forces to the growth of the service that General Aviation airplanes can perform for our society.

Thank you.

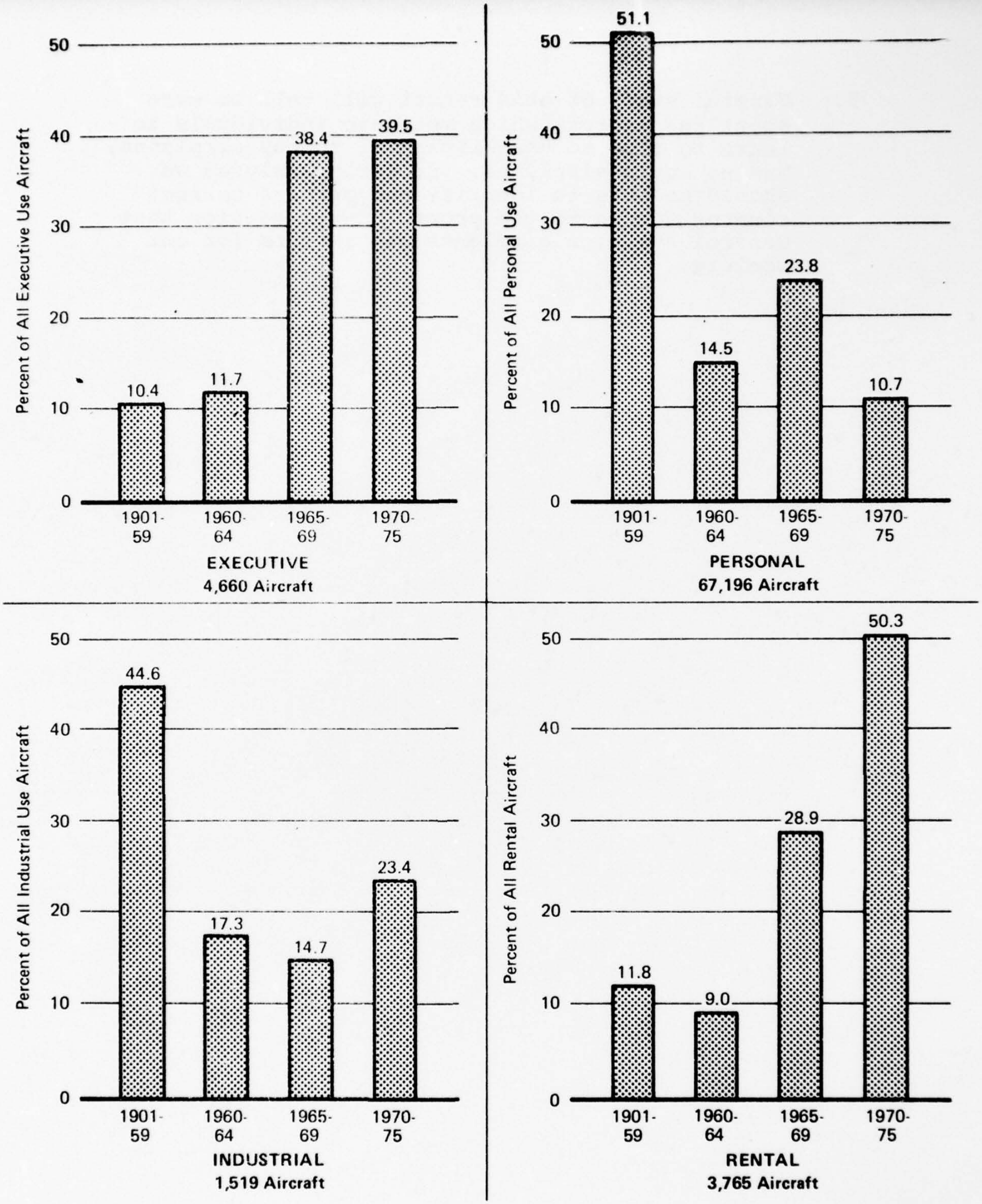


Figure 3 - 4

PERCENT DISTRIBUTION OF AIRCRAFT BY PRIMARY USE AND YEAR OF MANUFACTURE

GENERAL AVIATION DYNAMICS

- Michael A. Duffy, Gregory L. Eiden, and C. William Hamilton
Researcher Researcher Research Leader
Battelle Columbus Laboratories

Abstract

A system dynamics model of the general aviation system has been developed for the FAA by Battelle's Columbus Laboratories. The General Aviation Dynamics model can be used to forecast general aviation activity, evaluate alternative policy actions, or perform sensitivity analyses. It has three major sectors, depicting the most important state variables in the model; pilot supply, aircraft utilization, and aircraft demand. The system dynamics methodology was chosen because of its applicability in explaining the causal interactions between each of these sectors. Implemented in NUCLEUS, a computer software system developed at Battelle, an interactive dialogue feature is used to guide the unfamiliar analyst through a series of procedures and options. The General Aviation Dynamics model can be accessed almost any time and from anywhere in the U.S., provided a telephone, an on-line terminal, and an authorized user name and password are available.

Introduction

Credible aviation forecasts are essential to the Federal Aviation Administration (FAA) for two purposes; short-term forecasts provide support for the budgetary process, while long-term forecasts establish the basis for planning, research, and development necessary to meet the needs of the national aviation system. Of primary importance is an accurate assessment of the expected future growth of general aviation. These forecasts, already complex, become extremely difficult when evaluating possible alternative federal policies.

The General Aviation Dynamics (GAD) model is the result of a series of research programs concerned with the cost impact effects on general aviation activity, performed by Battelle Memorial Institute - Columbus Laboratories. Past studies concentrated on developing a consistent data base and methodology for determining, independently, the sensitivity of both numbers of aircraft and hours flown to cost changes. GAD was developed as a dynamic simulation model of the general aviation systems, which recognizes the important inter-relationships between all sectors of general aviation.

In essence, the GAD model consists of a set of nonlinear, simultaneous, first-order difference equations. These difference equations explicitly describe the decision policies followed by users of general aviation. The model can be used to simulate the dynamic behavior of the general aviation system in response to both exogeneous and endogenous disturbances. It cannot be expected to "predict" unforseen happenings that may occur.

In general, there are two ways to use model results or simulations--individually as projections and in pairs as sensitivity measures. Use of the model simply to make projections is precarious. Many potential users will not understand how the projections were derived and will expect unreasonable accuracy. The model is better used by employing extensive sensitivity analysis to evaluate a range of policies under a range of possible conditions. This process will identify the principal area of model uncertainty and those portions of the model that deserve the greatest additional research.

Definitions

Present FAA forecasting methods use a "top-down" approach for projecting aviation activity; that is an aggregate level for total GA activity is forecast and, subsequently, subdivided into various sectors of interest. The GAD model is based on a "bottom-up" approach providing distinct forecasts for activity within each significant user category/aircraft type subsegment.

Seven distinct user categories and seven different aircraft types were chosen for detailed analyses. Of the 49 different possible combinations, only 29 user category/aircraft type subsegments have had a significant amount of activity. Table 1 indicates user categories, aircraft types, and the significant subsegments.

During previous cost impact studies, major cost centers were defined for both the variable cost of aircraft operation and the fixed cost associated with aircraft ownership. These cost centers (Table 2) provide the means for translating fiscal policies into the behavioral response of GA users.

Methodology

The system dynamics approach for continuous simulation was chosen as the basis for model construction over alternative forecasting and policy analyses methods for several reasons. First, general aviation is comprised of many diverse users, each responding in unique ways to various endogenous and exogenous stimuli. Understanding the complexity of system behavior stemming from this diversity requires characterization of the time-dependent and interactive information feedback properties of the various sectors of the system. Second, because policy analysis applications entail evaluation of policy impacts in an uncertain future environment, it is desirable to be able to repeatedly test the validity of the model in terms of each of its internal behavioral properties; not simply in terms of aggregate statistical comparisons. Third, acceptance of any model as a suitable aid in making policy decisions requires consensus among those affecting and affected by such decisions that the model does, in fact, adequately represent the cause and effect behavior of the system. While recognizing that imperfections exist in any modeling approach, the General Aviation Dynamics model appears to best satisfy these requirements.

Originally developed at M. I. T., system dynamics has been in use at Battelle for over a decade. Recognizing the versatility of this modeling technique, a computer-based dynamic simulation and modeling system, NUCLEUS, has evolved as a result of numerous multidisciplinary research projects at Battelle. The GAD model, implemented in NUCLEUS, can be accessed almost any time and from anywhere in the U.S., provided a telephone, an on-line terminal, and an authorized user name and password are available. An interactive dialogue feature of NUCLEUS is used to guide the unfamiliar analyst through a series of procedures and options.

A system boundary was chosen which defines the concepts that interact to produce the behavior of interest. Interest here is in the mechanisms that foster the growth of general aviation activity. Three levels (state variables) were chosen as the cornerstones on which to build the system structure: aircraft, annual hours flown, and pilots. Each of these levels represents the principal variable in a major sector of the general aviation

system. The three levels interact in multiple ways, as indicated on the flow diagram of the entire system structure in Figure 1.

System dynamics flow diagram symbols are summarized in Figure 2. The system levels appear as rectangles. Note that the active aircraft level is subscripted i, j. This is to indicate that active aircraft are distinguished by the number of aircraft of type j (j = 1, 2, ...7) within user category i (i = 1, 2, ...7).

Rates are the system's action or policy variables which effect changes in the levels. Aircraft activation, destruction, and utilization rates control general aviation activity. Airman certificate issues and departure rates determine the active pilot population.

Since the rates acting on a level summarize the effects of all factors which influence the state of the level, they are generally complex expressions. Often one or more components of a rate are sufficiently important to warrant individual attention. These auxiliary variables are separated algebraically from the rate equation. One such auxiliary variable is the desired active aircraft parameter, which represents the goal that each subsegment is striving to achieve under the present system conditions.

The exogeneous inputs provide a direct means for the analyst to evaluate various fiscal policies and "what if" situations. Best estimates for these variables through 1984 are an integral part of the model; but they can be easily modified.

Dotted lines are used to indicate an information flow or causal influence in the direction shown by the arrows. Solid lines represent physical flows such as aircraft or people. Arrows located on either side of a rate (e.g., aircraft activation rate), indicate that the rate can be either positive or negative.

The Pilot Supply Sector

The number of active airmen is an important element in determining the demand for aircraft owned and operated by the same individual. Typically, these are business and personal aircraft. The pilot supply sector develops forecasts of the active pilot population by type of certificate, and also the number of both instrument and helicopter ratings.

The controlling factor in determining ultimate pilot population is the rate of student certificate issuances. By dividing the U.S. population over 16 years old into three distinct age groups, recent data can be used to show a definite relationship between student certificates issued, population, and relative cost of instructional flying.

A valid description of the pilot supply sector must recognize the required progression of steps necessary to qualify for advanced certificates. The inherent delays encountered in satisfying these requirements are an important part of the model definition. It is these delays that explain the continued growth in numbers of active pilots during times of reduced student issuances.

<u>The Aircraft Demand Sector</u>

The structure of the aircraft demand sector is identical for all subsegments of general aviation. Each subsegment has its own goal for a desired number of active aircraft which it is striving to achieve. The main difference between subsegments is in the functional expression for their respective goals.

The demand for aircraft that are owned and operated by the same individual (viz. business and user categories) is likely to be dependent on the supply of such individuals. This is, of course, the number of active certificated pilots. So it is relatively easy to conceive another parameter which describes the desired pilots-per-aircraft. As the number of active pilots increases, the demand for active (business and personal) aircraft will increase. However, in certain cases, the desired pilots-per-aircraft parameter is shown to be a function of total cost of operation and either GNP or DPI. Thus, as the relative economic attractiveness of owning an aircraft goes down, the same number of pilots will demand fewer aircraft.

The demand for aircraft that are used in providing a service (viz. aerial application, instructional, air taxi and rental) is dependent on the extent to which these aircraft are presently being used. Should the average annual utilization rate of a particular aircraft type within one of these user categories surpass some threshold, then there will be a need for additional aircraft to satisfy what may be an excess demand. The goal for desired number of active aircraft is related to the ratio of

desired aircraft utilization rate and actual aircraft utilization rate. Except for aerial applications, the desired aircraft utilization rates within other subsegments have been insensitive to changes in economic variables.

Demand for corporate aircraft is based on a desired number of active aircraft which is directly related to general economic conditions. Intuitively, this functional dependence is appealing. For, should economic growth be stagnated and real GNP remain constant, the desired number of corporate aircraft will remain constant. Ultimately, the demand for additional corporate aircraft would represent only replacement of destroyed aircraft. However, if the economy continues to grow, an ever increasing number of active corporate aircraft will be desired.

The Aircraft Utilization Sector

Several different behavioral subsegments are evident within the aircraft utilization sector. First is the owner-operator situation, characterized by the business and personal use categories. Here an aircraft is purchased and operated by the same individual. The average annual utilization rate for these aircraft have been varying about a nominal value. Thus, total annual utilization by each subsegment is obtained by taking the product of active aircraft and average annual utilization rate.

Demand for aerial application, instructional, and air taxi flying represents an aggregate demand for a general aviation service. The total annual hours demanded are distributed among the available aircraft to determine a derived annual utilization rate. These derived utilization rates are used in determining the demand for additional aircraft in these categories.

Behavior of the single and multiengine piston aircraft owners within the "other" use category, which are predominantly rental operations, is similar to the total hours flown approach. The remaining segments of the "other" use category are based on average utilization rates.

Different user category/aircraft type subsegments respond to different stimuli. Utilization, either average rate or total hours, has shown a significant correlation with variable cost of operation in only a few of the 29 subsegments. Some subsegments have indicated utilizations dependent on GNP, DPI, or the level of commercial air activity. However, the form of these dependencies is, in some cases, opposite the a priori expectation.

The forecasted level of annual hours flown is used to determine the corresponding level of operations within each subsegment. Operations are distinguished by local-itinerant, towered-non-towered, and IFR-VFR. Annual hours flown is also used in calculating the amount of both piston and jet fuel consumed.

The Dynamics of Aircraft Demand

The structure of the aircraft demand sector is identical for all subsegments of general aviation. However, because of the various uses of general aviation aircraft, the desired stock of active aircraft is determined differently for different users. At any point in time, each subsegment has a certain number of active aircraft and a desired number of active aircraft which it is striving to achieve. This desired stock can be greater than, less than, or equal to the actual number of active aircraft, depending upon other conditions within the system. Of special interest in explaining fluctuations in aircraft activation is the role of pilot population, average aircraft utilization rates, and exogenous economic parameters.

The demand for aircraft is a derived demand, the primary demand being for transport services provided by the aircraft. This derived demand is demand for a stock (or goal) of aircraft, not for the flow of aircraft activations. The goal, DAA, desired active aircraft, can be a complex function of the number of pilots, the average aircraft utilization rate last year, fixed costs, variable costs, and exogenous inputs for GNP or DPI. For any particular subsegment, if the stock of aircraft desired is greater than the current number of active aircraft within that subsegment, then additional aircraft will be activated; otherwise, aircraft would be deactivated. Thus, the dynamics within the general aviation system are the result of continuous causal interactions between the pilot supply sector, the aircraft utilization sector, and the aircraft demand sector.

To illustrate, consider the demand for business single-engine piston aircraft, displayed in Figure 3. DPPA, desired pilots-per-aircraft, relates the demand for business aircraft to the number of active pilots.

The goal for active aircraft DAA, desired active aircraft, is simply

$$DAA(I,J) = TP/DPPA(I,J)$$

where TP is total pilots and is equal to the sum of private plus commercial pilots when J identifies fixed wing aircraft.

Values for DPPA(1,1) over time can be determined from the data presented in Table 3. DPPA is not likely to be constant but should be reflective of general economic conditions as well as the relative cost of aircraft ownership. Figure 4 indicates the variation of DPPA(1,1) with percentage changes in GNP measured in constant 1972 dollars and indexed to the 1972 value of GNP. Results of a log-linear regression analysis are

$$\mathrm{DPPA}(1,1) = 20.0\ \mathrm{GNP}^{-3.23}$$

$$R^2 = 0.97$$

Similar analyses were performed for components of each rate equation within the GAD model.

Model Output

The GAD model can be used to forecast (or compare) active aircraft, annual hours flown, and total operations for each of the 29 user category/aircraft type subsegments identified in Table 1. Other forecasts that can be obtained are

- Active Airmen

    Student Certificates Outstanding
    Private Certificates Outstanding
    Commercial Certificates Outstanding
    Helicopter Certificates Outstanding
    Instrument Ratings Outstanding
    Helicopter Ratings Outstanding

- Annual Fuel Consumption

    Aviation Gas
    Jet Fuel

- Towered Airport Operations

    Itinerant
    Local

- Nontowered Airport Operations

    Itinerant
    Local

- Total Operations

    IFR
    VFR

- GA Contributions to the Federal Trust Fund.

SIMULATION OF THE MODEL

Baseline Forecast

The foundation for planning and policy evaluation by the FAA must be a baseline forecast of uninhibited general aviation activity. Data required for this baseline forecast are entirely self-contained within the model. GNP, DPI, and the current dollar deflator are derived from the Wharton national economy forecasts. Estimates of revenue aircraft departures, variable costs, and fixed costs are representative of current FAA expectations. Values for each of these parameters are included through CY 1984.

Figure 5 illustrates the expected growth in numbers of active general aviation aircraft and annual hours flown.

Evaluation of the Ullman Bill

HR 6860, the revised Ullman Bill, was of primary interest to the general aviation community because of its proposal to impose a conservation tax on gasoline. Assuming that the bill had become effective on January 1, 1977, and that a 23-cents-per gallon conservation tax (the maximum tax proposed in the Bill) had been instituted, the GAD model indicates that the resultant increase in variable operating costs would reduce general aviation activity as shown in Figure 6. However, general aviation contributions to the Federal Trust Fund would increase to $279 million during 1977 (Table 4) as opposed to the $60 million expected in the baseline forecast.

Sensitivity Analysis

Relative comparisons can be made between the model forecasts from any two simulations. In particular, during a sensitivity analysis, absolute forecasts for each simulation are available, and also percent deviation between the two cases. These deviations can be displayed over time either graphically or in tabular format.

Sensitivity results are derived within the program by subtracting the results of the second simulation from the first simulation, dividing by the first simulation, and multiplying by 100 to convert differences to percent deviations from the base case. By continually computing these deviations over time, the nonlinearity in system response is preserved.

Figure 7 illustrates relative comparisons between the two previous simulations.

Summary

Models reflect the specific purposes for which they were designed and the particular techniques selected. A model of this type cannot be all things to all users. Inclusion of variables and interaction within a model is tantamount to recognizing their explanatory value, while omitted parameters are regarded as unimportant for the specified objectives.

The General Aviation Dynamics model represents (we believe) a significant advance, although it still has considerable room for future improvements. Some parts of the model are more thoroughly understood than others. This is partly because of the more stable behavior of certain subsegments within general aviation. For this reason, the model is better judged according to its overall structure, rather than by scrutiny of its individual parts. The real significance of the model is in the structure which defines the causal interactions between various components of the entire general aviation system.

In applying the GAD model to problems other than those for which it was designed, it may be necessary to introduce modifications, append additional sectors, and elaborate some sectors already in the model. The basic approach has been demonstrated; future applications are numerous.

Acknowledgment

This research was performed for the FAA under Contract No. DOT-FA74WA-3485.

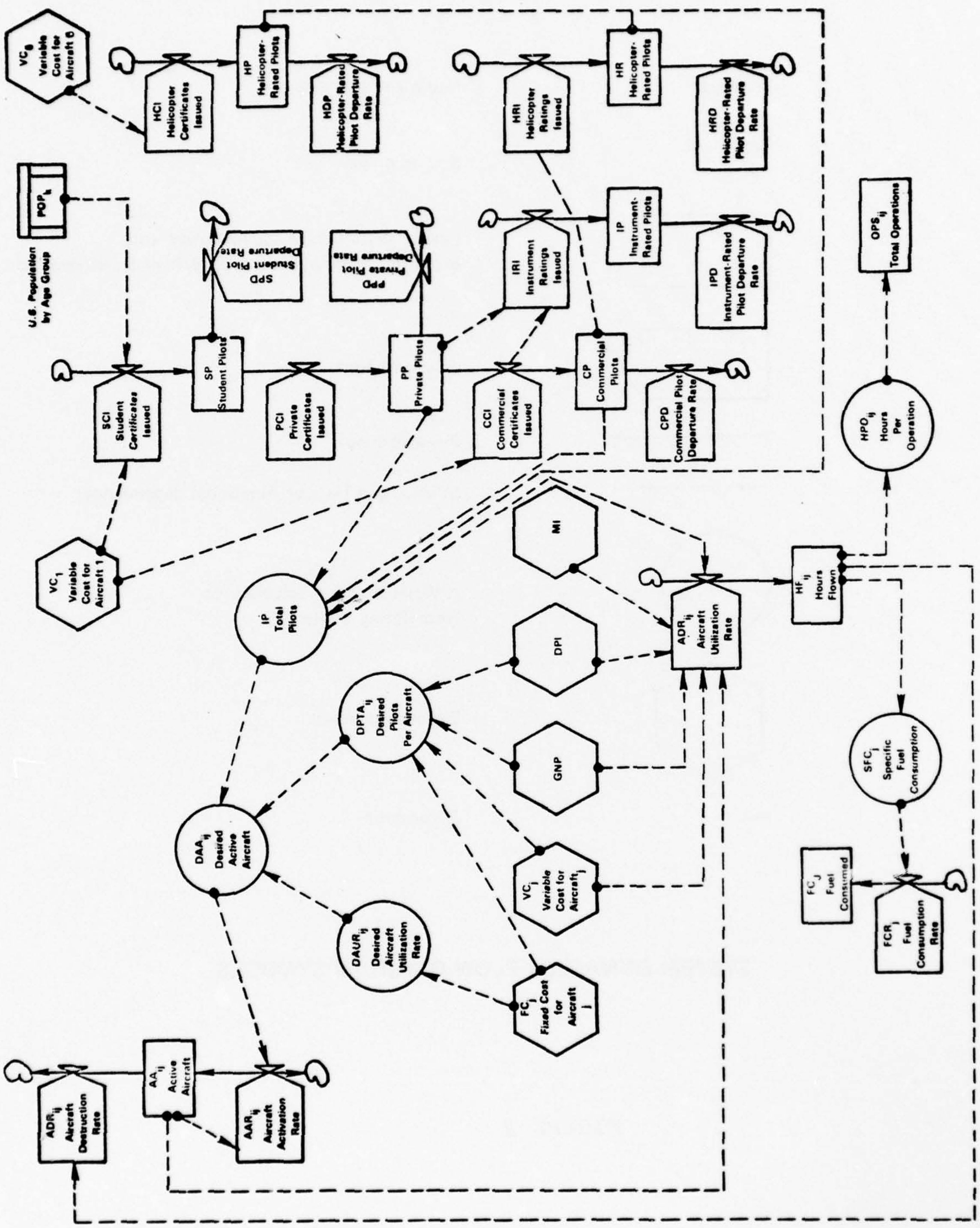
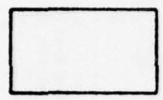
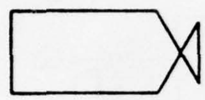
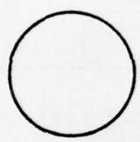
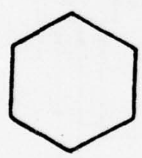
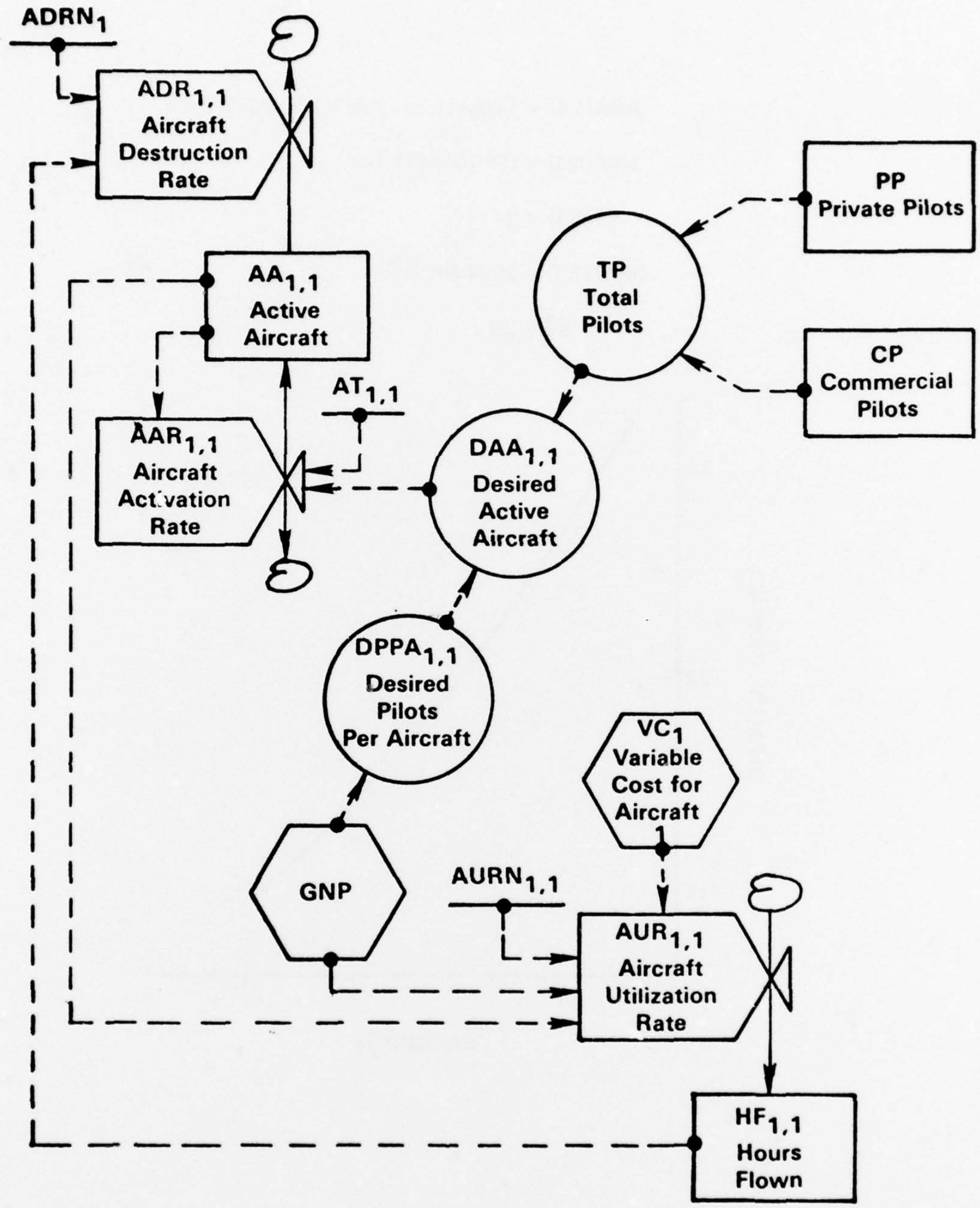


FIGURE 1. GENERAL AVIATION DYNAMICS FLOW DIAGRAM

Symbol	Name and Meaning
	*Source* or *sink*
	*Level:* the result of accumulation and depletion of flows, i.e., the result of an integration
	A *rate* of flow
	Physical flow
	Information flow or functional dependence
	A variable that is *auxiliary* to formulating a rate
	Exogenous input
	A *constant*

SYSTEM DYNAMICS FLOW DIAGRAM SYMBOLS

FIGURE 2



BUSINESS/SINGLE-ENGINE PISTON EXAMPLE

FIGURE 3

$$AAR(1,1) = \{DAA(1,1) - AA(1,1)\} / AT(1,1)\cdot$$

$$DAA(1,1) = (TP)/DPPA(1,1)$$

$$AT(1,1) = 2$$

$$DPPA(1,1) = 20.0 GNP^{-3.23}$$

$$R^2 = .97$$

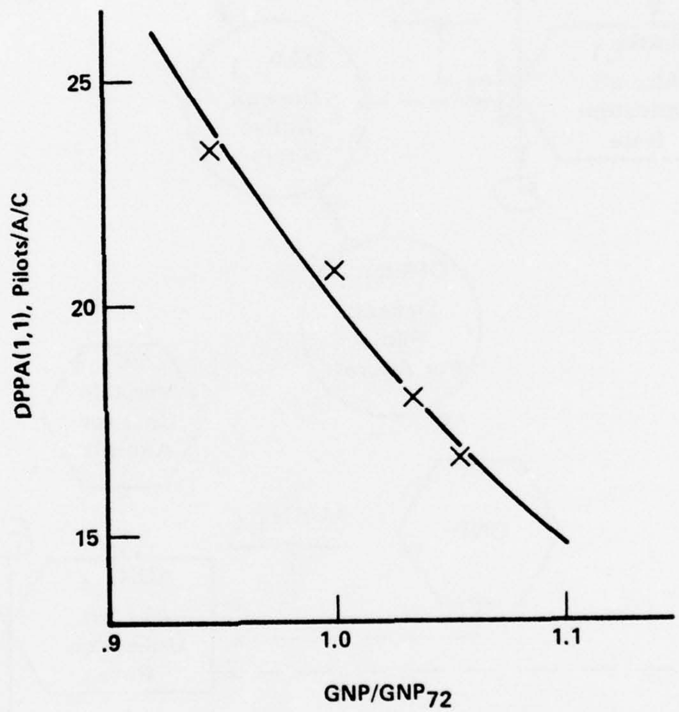


FIGURE 4

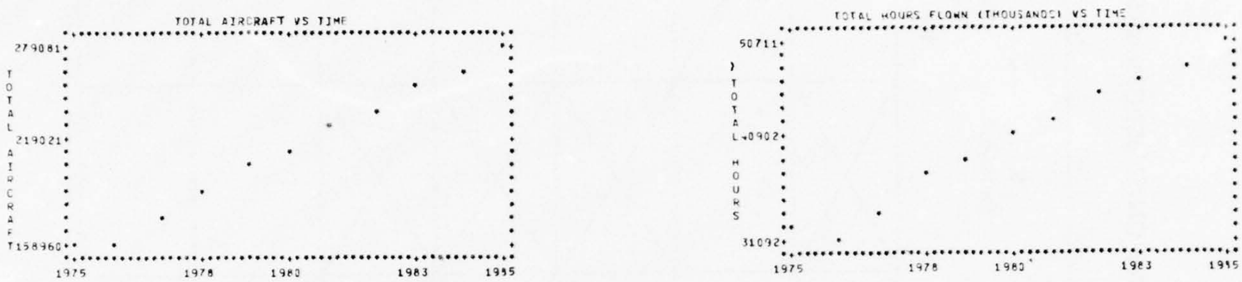


FIGURE 5. BASELINE GENERAL AVIATION ACTIVITY FORECAST

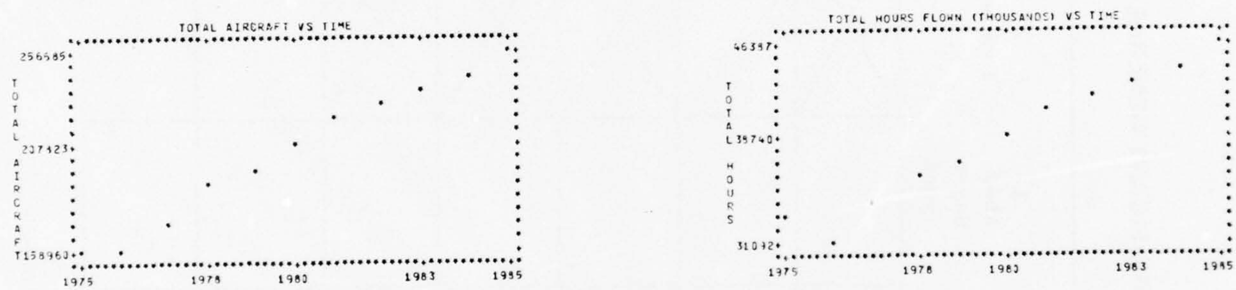


FIGURE 6. EXPECTED GENERAL AVIATION ACTIVITY UNDER THE ULLMAN BILL

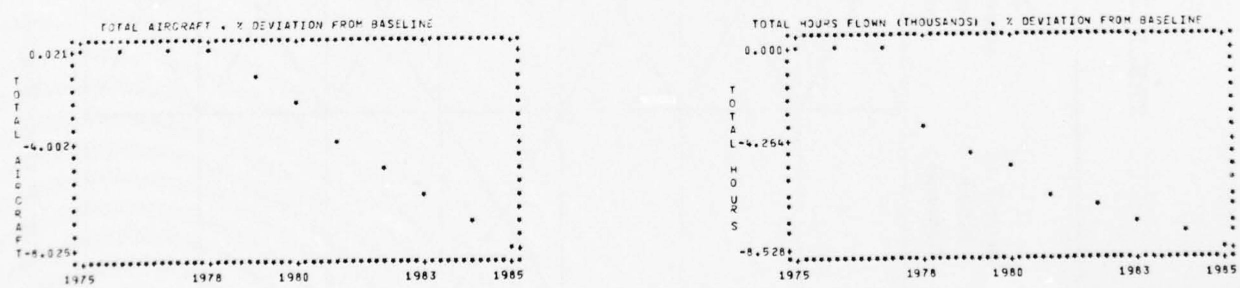


FIGURE 7. BASELINE/ULLMAN BILL COMPARISON

FIGURE 5

TABLE 1. SIGNIFICANT GENERAL AVIATION SUBSEGMENTS

User Category I	1. Single-Eng. Piston Nonaerial	2. Single-Eng. Piston Aerial	3. Multi-Engine Piston	4. Turboprop	5. Turbojet	6. Piston Engine Helicopter	7. Turbine Engine Helicopter
1. Business		X		X	X		X
2. Corporate		X				X	
3. Personal		X		X	X		X
4. Aerial	X			X	X		X
5. Instruct.		X		X	X		X
6. Air Taxi		X					
7. Other		X					

X Denotes Insignificant Amount of Activity

KEY TO TABLE 1

User Categories

1. Business Transportation
2. Corporate Transportation
3. Personal Flying
4. Aerial Application
5. Instructional Flying
6. Air Taxi
7. Other

Aircraft Types

1. Single-engine nonaerial
2. Single-engine aerial
3. Multiengine piston
4. Turboprop
5. Turbojet
6. Piston-engine helicopter
7. Turbine-engine helicopter

TABLE 2. COST CENTERS FOR GENERAL AVIATION AIRCRAFT

Variable Costs ($/hour)

- Fuel and Oil
- Airframe and Avionics Maintenance and Overhaul
- Engine Maintenance and Overhaul

Fixed Costs ($/year)

- Annualized Investment
- Hull Insurance
- Liability and Medical Insurance
- Hangar, Storage and Tie Down
- Federal Registration Fee and Weight Tax
- Miscellaneous

TABLE 3. ESTIMATED DESIRED-PILOTS-PER-AIRCRAFT IN THE BUSINESS/SINGLE-ENGINE PISTON SUBSEGMENT

Year	AA (1,1) as of Jan 1	ADR (1,1) During	AAR (1,1) During	TP= PP+CP Jan 1	Estimated DPPA(1,1) During
1971	20,522	94	-344	467,000	23.54
1972	20,084	93	1549	481,000	20.75
1973	21,540	114	3943	490,000	16.65
1974	25,369	125	768	481,365	17.89
1975	26,012			498,273	

TABLE 4. FEDERAL TAX REVENUE DURING PREVIOUS YEAR AS REPORTED ON JANUARY 1 OF DESIGNATED YEAR

1976	$ 48,261,497
1977	54,555,921
1978	278,807,635
1979	300,291,725
1980	323,703,613
1981	349,082,650
1982	373,988,338
1983	397,021,476
1984	421,258,667
1985	456,818,116

REPRESENTATIVE QUESTIONS AND ANSWERS

Questions Relating to Air Carrier Forecasts.

For the purposes of these forecasts, what is your fiscal year?

> Previously, the fiscal year started on July 1 and ended on June 30. It now starts on October 1 and ends on September 30.

The figures that were provided for the discussion on air carriers, are they CAB figures?

> Yes, they are the CAB figures.

Do you have the figures on average annual growth for air carriers?

> Yes, we do. Most of the data which will be presented are in copies of the speeches and in various publications which will be available in the lobby.

What about charter traffic? What growth do you forecast in this area?

> A forecast of charter traffic is not included in our publication. However, there will continue to be an increase in charter traffic and the growth rate is expected to be greater than is forecast for scheduled traffic.

When you developed your figures did you take into consideration constraints, such as the ability of air carriers to buy equipment?

> Yes, some constraints were taken into consideration. It was assumed that air carriers will be able to purchase equipment to carry the additional traffic from increased growth; however, we have assumed that the air carriers will not be able to replace older aircraft as soon as they might wish.

Assuming continuation of production of standard-body models, what about FAR 36?

> We have assumed, that only the 727, DC-9 and 737 will continue in production for U.S. carriers. These aircraft meet FAR-36 rules.

The Boeing 747 you said was on order has this been purchased by a domestic or foreign air carrier?

> The 747 mentioned was purchased by Northwest Airlines and is a freighter version. All the aircraft order information on the table I showed you was for U.S. air carriers.

You assume that the size of the average air carrier aircraft will be getting bigger. Do you think there will be a new aircraft in the size of, say, 100 seats?

> We have assumed that there will be no new aircraft introduced in the 100 seat capacity range, but that derivatives of the DC-9 and 737 will be used to fill this need.

What percent of possible air carrier traffic is being carried by general aviation aircraft.

> We have no firm data on this; but we estimate that between 1 percent and 2 percent of the potential air carrier traffic is being carried by general aviation aircraft.

Is there any documentation recording the amount of cargo carried?

> The figures are in our publication. They are reported in both tons enplaned and ton-miles flown. These statistics are for CAB regulated carriers.

Questions on General Aviation

How much consideration do you give to saturation?

> No consideration has been given to saturation on the national level. However, when we make forecasts of activity levels of specific airports possible effects of saturation might be a factor and are considered then.

I think you misunderstood my question. I refer to the growth of the general aviation jet aircraft fleet and activity levels, and I wonder how the market can continue to support the implied sales. How many people, for example, will be buying business jets?

> We do not have market analysis data at such a fine level of detail. However, as I mentioned earlier the general aviation manufacturers are engaged in an intense sales promotion campaign. To the extent that such efforts succeed, the market for business aircraft is expected to remain buoyant.

I notice that there are no forecasts on aircraft production in this year's forecast publication as we had in previous years (see, for example, Aviation Forecasts Fiscal Years 1976-1987, September 1975, Table 9). Could you comment on this omission?

> We had prepared a forecast of aircraft production extending through 1988. However, in a preliminary review of the forecasts, the General Aviation Manufacturers expressed some concern about the accuracy of some of the base data and the forecasts of specific aircraft types derived from these data. For this reason, FAA decided to refrain from publishing the data this year, particularly since reliable forecasts are critical to the manufacturers and to the lending institutions. The data are used internally at FAA and will be made available to anyone who requests them.

The chart on pilot statistics shows the number greater in 1972 than in 1976; but you projected an increase through 1982. Please comment on this.

> This was a problem of data collection and recordkeeping. FAA went through the files in Oklahoma City and purged them of duplicate and erroneous entries and this brought

the base level down in 1974. The forecasts are in line with the long term trends. In addition, the General Aviation Industry is on a "hard sell" campaign to increase the number of pilots through their "Take-off" program and such efforts will help to increase the growth rate of the pilot population.

What specific assumption is there for fuel and oil consumption?

Our assumption was that there will be a 7 percent annual increase in fuel prices in real terms during the forecast period. The same assumption was used for both GA and AC forecasts.

Questions Relating to Air Taxi and Commuter Forecasts

Is there any breakdown in scheduled and non-scheduled air taxi operations?

> No there is no breakdown. When the commuter airline forecast is completed, we will have data for scheduled commuter operations.

Is there any breakdown into what proportion of commuter traffic is business travel?

> No one has made an indepth study, but there was a study done by a California group some time ago which indicated that 80 percent of travel was for business purposes. That seems to be a generally accepted figure.

Do you have evidence that the increase in demand in air taxis is new demand or diverted from general aviation?

> Some industry representatives believe that because commuters offer more frequent service than air carriers when they enter a market, the commuters tend to divert some traffic from general aviation. However, the higher level of service also tends to create new demand. For example, Allegheny's Hensen Aviation offered good connecting service to Baltimore and National airports and their traffic increased over what Allegheny had been carrying with two flights a day.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1977 0-240-897/87